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JUNE, 1943

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ANNALS
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Volume XXXVI JUNE, 1943 No. 2

NOTES ON ODONATA OF SURINAM

IV.[1] Nine New or Little Known Zygopterous Nymphs From the Inland Waters

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The nymphs of the rich neotropical Odonate fauna are but very poorly known. In this contribution nine nymphs are described, of which seven were identified by rearing or by the study of the wing venation and the penis. These will be of importance for our knowledge of the nymphal characters in general and concerning the systematic position of some doubtfully arranged species.

The first five species are stream-dwellers, living in the running water of creeks and rivers, whereas the last four species are inhabitants of standing water and were collected in flat savanna pools or in small rivulets between these pools.

The mentioned species are all new records for this country.

Oxystigma petiolatum Selys

Nymph (hitherto unknown), Plate I.

A short, stout-bodied, black-marked nymph, with swollen triangular gills. Head large, broader than long, the eyes less prominent, hind angles swollen, spinulose on the outer edge, occipital border highly excavated. Black markings as shown in fig. A, Plate I. Antennae relatively short, first segment with a darker ring, second segment somewhat darkened below, otherwise pale; relative length of the segments 16 : 23 : 22 : 20 : 12 : 8 : 8. Segments 1–2 covered with long, flattened scales, segments 3–6 with an apical fringe of hairs.

Mentum broad and somewhat quadrangular, reaching backward to just behind the first coxae, the sides in the basal half diverging, in

[1]Part I. *Rimanella arcana* Needham and its nymph (Odon. Zyg.). Revista d. Entomologia, 11 (1–2): 173–179; 8 figs. 1940.

Part II. Six mostly new Zygopterous nymphs from the coastland waters. Ann. Ent. Soc. Amer., 34: 719–734; 6 figs. 1941.

Part III. The genus Coryphaeschna, with descriptions of a new species and of the nymph of *C. virens*. Ent. News, 54: 61–72. 1943.

the apical half more parallel, the margin in the middle for a larger part armed with teeth alternating with simple hairs. No mental setae present; median lobe rounded and irregularly denticulated, in the middle with a small cleft. Lateral lobes without lateral setae; movable hook large, end hook small and blunt, pointed downward, terminal border with two large dents; inner margin of lobe denticulated.

Maxilla of right side: end tooth with three small basal teeth, followed below by six larger setae and three smaller ones and with five lateral setae; inner side with three equally sized large teeth, followed below by six larger setae and three laterals. Left maxilla the same, but with three lateral setae (not five) in the outer row and with four laterals (not three) in the inner row.

Mandibules stout, two branched, external branch larger with five unequally sized teeth (4 and 5 fused together); right mandible with a basal tooth below the first large dent; internal branch of left mandible larger than that of right mandible, its apex truncated and with seven teeth or crenations, dorsal-most largest. On the right mandible the apex of the internal branch is pointed and has only two teeth. The basal outer corner of both mandibles with a truncated tridentate and hairy part.

Prothorax broad, hind margin convexly rounded, middle lobes and hind lobe with black areas, middorsal line in the apical half pale. Synthorax broad, as broad as head, intensively marked with black stripes in the front along the middorsal carina and on the sides along the lateral suture.

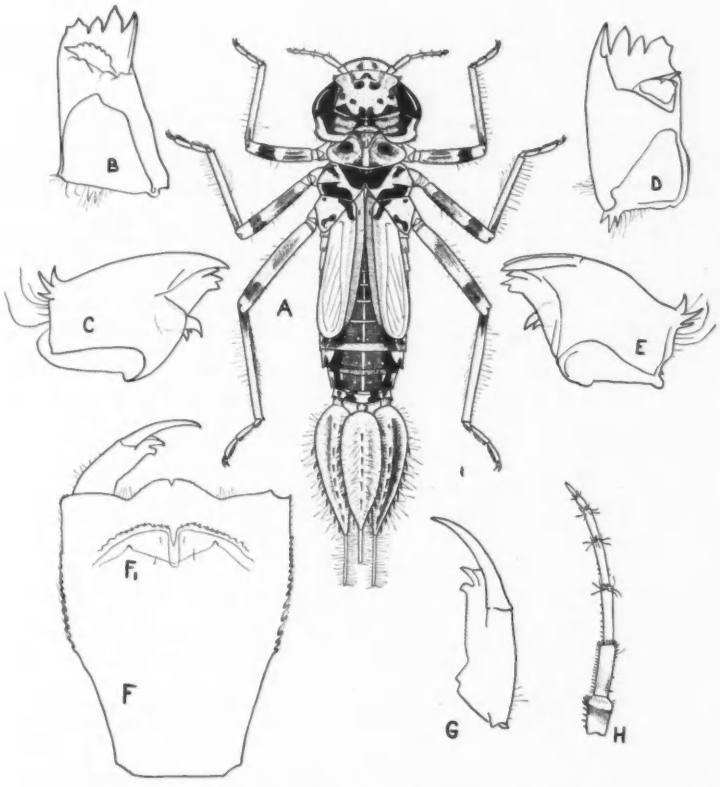
Wing pads reaching to mid-length of segment 7. Legs relatively long, femora not flattened, with a darker apical ring and a darker area more basally. Apical end of the first tibia and the three tarsal segments armed with plumose setae only, those of the middle and hind tibiae with plumose and simple setae and with three short, strong spines (spurs); middle and hind tarsi with simple and plumose setae on the first segment, on the second and third segment with plumose setae only. An empodium-like structure present between the claws.

Abdomen relatively broad, the last two segments much smaller, dorsal side in cross-section convex, ventral side flat. Dorsum for the most part dark with a middorsal pale line over all the segments, on segments 7–9 the dark area black on the sides and followed more laterally by a lighter part. On segment 10 the darker areas are reduced to four spots.

Gonapophyses of male absent and with no indication of elevated points.

Gills enormous, swollen, triangular in cross-section, petiolated at base and with a slender taillike tip end. Swollen portion ovoid, flattened and somewhat impressed on the opposed surfaces, so that the dorsal and lateral margins are more or less ribbed. These ribs are armed with a row of strong curved spines; other parts and slender tips hairy.

Total length, including gills, 14.75 mm.; lateral gills 5.2 mm.; dorsal gill 4.4 mm.; abdomen 5.0 mm.; largest width of head 3 mm. One ult male examined.



Oxystigma petiolatum Selys. A, dorsal view of full-grown male nymph; B, left mandible, inner side; C, left mandible, lateral view; D, right mandible, inner side; E, right mandible, lateral view; F, mentum, inner side; F_1, median cleft, enlarged; G, right lateral lobe of mentum; H, antenna.

This remarkable nymph was collected in the Makami-creek near Kabelstation, Sept. 22, 1938, where it was found between leaves and twigs in the clear running water. The identification was secured by a careful study of the wing venation. Imagines of this species were commonly found in the nearby woods.

In the system of Kennedy (1920), *Oxystigma* belongs to the Megapodagrioninae. This position seems to be correct according to the structure of the nymph, for the nymph has many features in common with some other genera belonging to this subfamily, such as the less cleft median labium border, the absence of mental and lateral setae, the terminal border of the labial lobe with two teeth, the two-branched (biramous) mandibles, and the shortened and swollen gills. The known nymphs of this subfamily are *Thaumatoneura* (Calvert, 1915), *Argiolestes* (Tillyard, 1917), and *Rhinagrion* (Needham, 1911; Needham and Gyger, 1939). The nearest relatives of *Oxystigma* in the Amphipteryginae, *Hypolestes* (Needham, 1911) and *Diphlebia* (Tillyard, 1909), do not have biramous mandibles (*Hypolestes*).

The nymph of *Oxystigma* differs from that of *Rimanella* (Geijskes, 1940) by the swollen gills, the lack of external gill tufts, and the divided labial lobe. It differs from the Epallaginae (*Pseudophaea*; Ris, 1912, and Needham and Gyger, 1939) and Polythorinae (*Cora*; Calvert, 1911) by the absence of the lateral abdominal gills, and from the Platystictinae (*Drepanosticta*; Lieftinck, 1934) by the toothed labial lobe, whereas the Agrioninae (Calopteryginae) and Libellaginae are differentiated by the hypertrophied first antennal segment and the deeply cleft mentum.

Hetaerina dominula Hagen

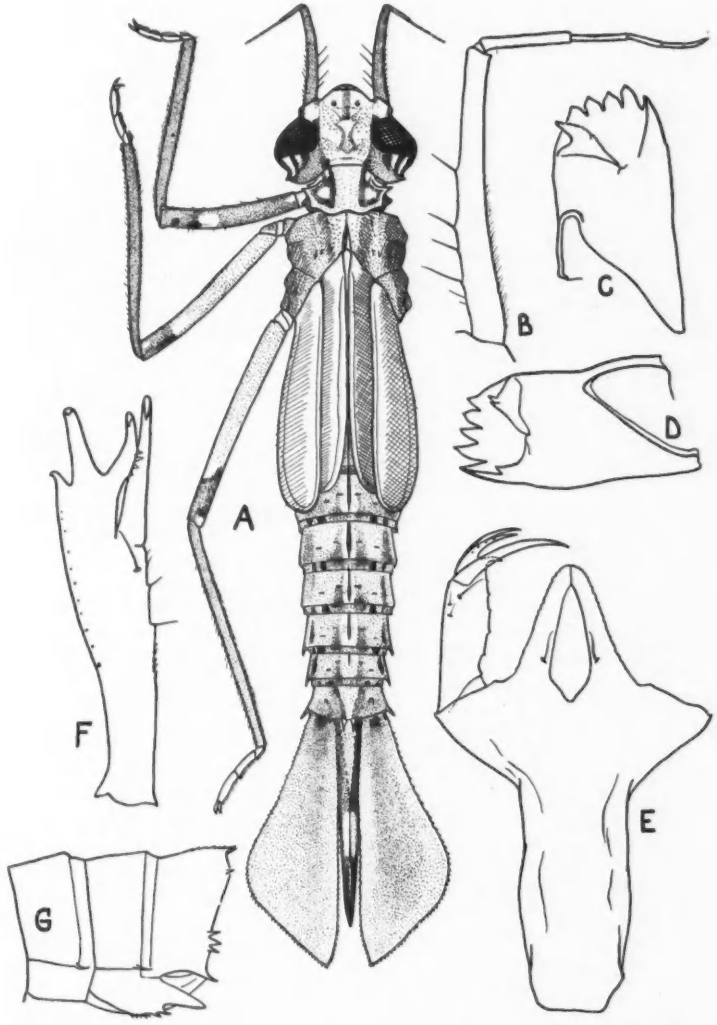
Nymph (hitherto unknown), Plate II.

A long stalky dull brown nymph with the triquetral lateral gills widened and with lateral spines on the last three abdominal segments.

Head moderately broadened and flattened, the eyes prominent and set forward, hind lobes toothed, occipital border widely excavated. Antennae with the first segment hypertrophied, longer than the remaining part, stalky, dark brown, inner side with a few (5–6) setae, outerside hairy; relative length of the segments 125 : 40 : 24 : 15 : 7 : 7 : 8.

Mentum long, more or less spoon-shaped, reaching backward to between the second coxae, suddenly dilated in its apical half; median border very prominent and divided into two lobes by a median cleft, extending below to the level of the bases of the lateral lobes, the distal end of the cleft closed by the apposition of the two divisions of the median lobe; beside the cleft on either side is a single seta. Lateral lobe with a straight outer margin and with a long curved movable hook, just before the base of which on the superior margin are three small setae; terminal border with two large equally sized arcuated and somewhat diverging dents, the dorsal one with four denticulations along the upper margin; end hook smaller, inner margin of lobe slightly convex and serrulated.

End tooth of maxilla with three small basal teeth, followed by



Hetaerina dominula Hagen. A, dorsal view of full-grown female nymph; B, right antenna; C, left mandible, inner side; D, right mandible, inner side; E, mentum, inner side; F, right lateral lobe of mentum; G, end of abdomen of female, left lateral view.

seven larger setae and nine to twelve smaller lateral setae; upper inner margin with three large equally sized teeth, of which the last one is more curved, followed below by seven longer setae and six or seven smaller laterals.

Mandibles two-branched, the outer branch with five teeth of nearly equal size; right mandible with a basal tooth on the largest ventral dent; inner branch of right mandible with two teeth, that of left mandible with a truncated and denticulated plate.

Dorsum of prothorax with a lateral pointed prominence in the front part and with a less pointed or rounded prominence in the apical part. Synthorax as broad as head, wing pads reaching backward to the end of segment 5. Legs long and slender; femora lighter in the basal three-fourths, followed by a darker ring just before the knee, except in the first femur, which is darker from its base to the apical pale ring proximad of the darker end part; tibiae dark brown, tarsi paler; end of tibiae and tarsal segments beset with plumose setae.

Abdomen relatively broad, slowly tapering to the end; segments 8 and 9 with a sharp flat lateral spine; segment 10 with three spines on the lateral carina, and with two larger middorsal setae along the apical border and one smaller pair more laterally. Dorsum dull brown, a paler middorsal stripe over the last six segments, interrupted by a black line in the median to the basal half of segment 9; sides darker with some black spots.

Gonapophyses of male short, pointed, reaching to the end of segment 9, beset with a row of short setae; gonapophyses of female reaching to the end of segment 10, inner pair strongly curved upward, outer pair denticulated on the ventral margin, end tooth large.

Gills large, the two laterals triquetral and considerably widened in the apical half (length : width = 3 : 1), the apices rather pointed, the margins serrulated; the median gill flat and shorter than the laterals, dark brown with a paler part at two-thirds the length. In some darker individuals the lateral gills are banded with dark at the base and over the apical half.

Total length, including first antennal segment and gills, 22.0–22.5 mm.; first antennal segment 2.5 mm.; abdomen 8.0 mm.; lateral gills, 5.0–6.0 mm., median gill 4.5–5.0 mm.; largest width of head 3.0 mm. One male and one female ult nymph examined.

The nymphs of this common species were found in some creeks in the interior (Coropina-creek, Makami-creek near Kabelstation and Waremapan-creek in the Tumuc Humac Mountains) as well as in the falls of the Surinam river near Kabelstation. They rest between debris of leaves and twigs and between the large leaves of the Mourera-plants (Podostemonaceae) in the falls of the river. The species was identified from an emerging male from the Coropina creek (4. IV. 1942).

Of the numerous species of *Hetaerina*, only the nymphs of *H. americana* Fabr. (Needham, 1903) and of *H. titia* Drury (Byers, 1930) seem to be described at length. The nymph of *H. americana* differs from that of *H. dominula* by the less widened lateral gills, the lateral abdominal spines on segments 7–9 (instead of 8–9) and in the length of the two teeth on the terminal border of the lateral mental lobe, of which

the one next the end hook is twice the size of the other above it (in *dominula* the teeth are equal in size).

The nymph of *H. titia* is very similar to that of *H. dominula*, and according to the original description, there is no difference except its smaller size and some variation in the darker bands on the gills.

Hetaerina moribunda Hagen (supposition)

Among the *Hataerina* nymphs in my collection there are three specimens which, although very similar to the described nymph of *H. dominula*, show the following points of difference: abdominal segments 7–9 with a lateral spine on the carina (on 8–9 in *dominula*), the general appearance smaller and paler, the legs pale, except a small black point near the apical end of the femora, and only the basal part of the first femur darker; lateral gills less dilated in the middle (length : width = 4 : 1), otherwise the same as in *dominula*; the first antennal segment longer, relative length of the segments 130 : 38 : 23 : 14 : 7 : 7 : 7.

Mouth parts and other details as in *dominula*.

Total length, including first antennal segment and lateral gills, 20.0–21.5 mm.; first antennal segment 2.3–2.5 mm.; abdomen 7.7–8.5 mm.; lateral gills 6.3–6.7 mm.; median gill 5.0–5.2 mm. Surinam, Kabelstation Makami-creek (22. IX. 1938), one male and two female ult nymphs examined.

The only other species of *Hetaerina*, besides *H. dominula*, found as adults along this and many other creeks in the lowland bush, is *H. moribunda* Hagen. The determination of this nymph is based on this observation.

Hataerina sp.

From a springlet at the top of the Brownsberg (400 m.), two not full-grown nymphs were collected (16. IX. 1938) which are readily separable from the two foregoing species by a small elevation or knob at the apical end of the middorsum of abdominal segments 3–10 and by two setae on the median lobe of the mentum along the cleft. Some other peculiarities are as follows: eyes black on the outer half, this black prolonged forward over the sides of head to along the outer side of the first antennal segment and downward over the sides of the hind lobes of head. In the middle of head, four longitudinal, more or less zigzag, lines. Sides of synthorax and abdominal segments 1–5 with two lateral darker stripes, each side of segments 5–8 marked only with two black dots on the apical margin of the segment. Legs pale, femora with two darker rings, one in the middle and one more apically.

Hind lobes of head very prominent, with an obtuse tooth. Prothoracic dorsum quadrangular, in the middle of the side margins a toothed prominence, hind angle acute. A lateral spine on abdominal segments 8 and 9, lateral gills triquetral and moderately dilated in the middle (length : width = 15 : 4), three darker crossbands present, tip acute, margins serrulated.

Mentum reaching backward to between the second coxae, of the ordinary *Hetaerina* shape as in the preceding species; two setae along

the cleft in the median lobe, a smaller upper one and a larger one below; other mouthparts as in ***dominula*** and ***moribunda***.

Total length, including first antennal segment and gills, 11 mm.; first antennal segment 1.48 mm.; abdomen 4.2 mm.; lateral gills 3.0 mm., median gill 2.6 mm.; largest width of head 1.65 mm. One female nymph not full-grown (3? ult) examined.

Total length, including first antennal segment and gills, 16 mm.; first antennal segment 2.18 mm.; abdomen 6.0 mm.; lateral gills 4.3 mm. (median gill broken); largest width of head 2.31 mm. One female nymph (not full-grown; 2? ult) examined.

Concerning the question to what species this nymph belongs, we are fully in doubt. Other species of ***Hetaerina*** found in Surinam and Demerara are ***mortua*** Hagen and ***laesa*** Hagen, but these were not observed on the collecting place. There is also a chance, although a very little one, that the species is a representative of another genus, viz., ***Lais***, ***Neocharis*** or ***Iridictyon***, the only other genera of ***Agrioninae*** known at present from Surinam and Demerara. As this question is only to be solved by future research work, it seems the best now to retain the species provisionally under ***Hetaerina***.

Argia insipida Hagen

Nymph (hitherto unknown), Plate III.

A stout-bodied nymph with large head and thorax, somewhat flattened femora and short oval gills; the body, legs and gills dark brown, spotted with lighter dots.

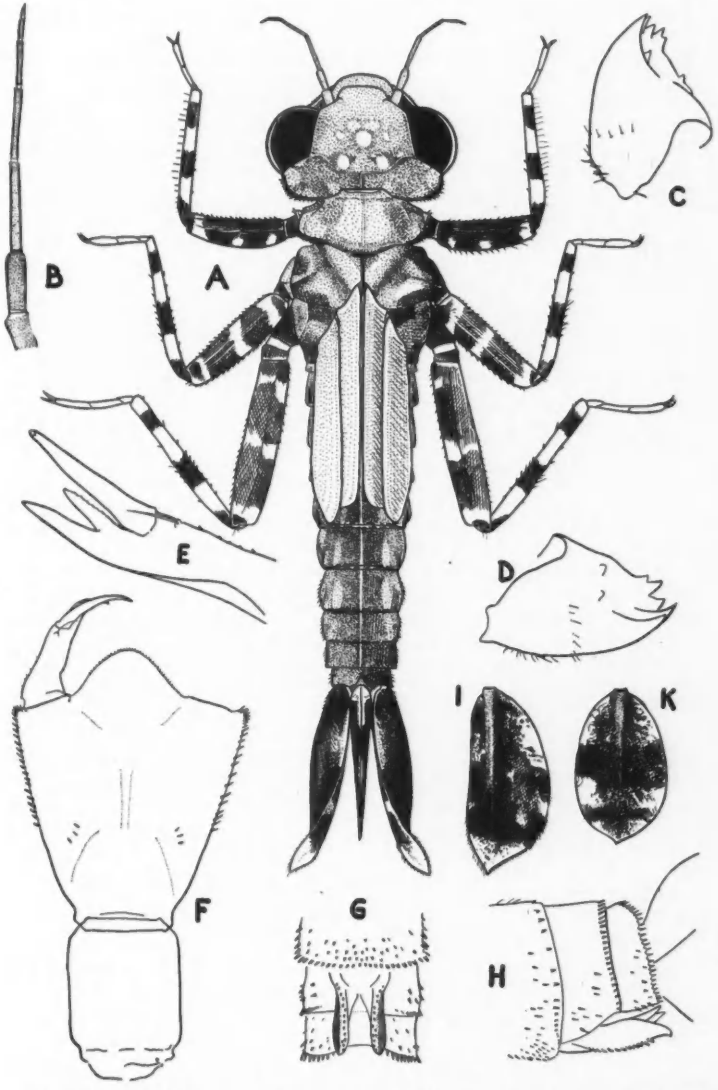
Head large, flat, broader than long (5 : 3), hind angles swollen and rounded, spinulose. Antennae thin and simple, 7-segmented, relative length of the segments 13 : 22 : 38 : 28 : 18 : 8 : 6.

Mentum broadly triangular, reaching backward to behind the first coxae, the sides diverging, armed with a row of small spines over the apical two thirds; no mental setae present, but in the basal part each side with three small spines; median lobe very prominent and rounded, finely denticulated. Lateral lobes with one slender seta; movable hook large and somewhat curved, end hook long, separated by a deep cleft from the terminal border, which consists of a long tooth, denticulated superiorly.

Maxilla of right side: end tooth with two basal teeth, followed below by five strong setae and several rows of finer setae, in total twenty; inner side with three large teeth of equal size, followed below by eight larger setae and six slender setae more laterally. Maxilla of left side: end tooth with two basal teeth, followed by twenty-four setae, inner margin with three large teeth of equal size, and with two rows each of nine finer setae.

Mandibules with five unequally sized teeth, both left and right mandible with two teeth on the inner surface, outer side with a transverse row of small setae.

Prothorax broader than long, flat, hind margin convex. Synthorax large, nearly as broad as head, the wing pads reaching in the female to the end of segment 5, in the male to the end of segment 4. Legs



Argia insipida Hagen. A, dorsal view of full-grown female nymph; B, right antenna; C, right mandible; D, left mandible; E, right lateral lobe of mentum; F, mentum, inner side; G, end of abdomen of male, ventral view; H, end of abdomen of female, left lateral view; I, left lateral gill; K, median gill.

large, the femora flattened, for the most part dark brown to black, with three white rings, one basal, one in the middle and one at the apical end; tibiae white, with three black rings; tarsi pale; apical end of tibiae with simple, divided (trident) and plumose setae, tarsi with plumose setae only.

Abdomen relatively broad, tapering to the end, dark brown with some lighter spots laterally and with a fine pale middorsal stripe over the segments; segments 7–10 densely spinulose. Male gonapophyses rounded, with a blunt apex, beset with a row of small short spines on the under side, reaching backward to the posterior margin of segment 10; female gonapophyses with the outer pair somewhat longer than the inner pair, reaching to beyond segment 10, the ventral margin with a row of short spines, apex curved downward.

Gills short and thick, oval-round with a small end point, the laterals longer than the middorsal gill, which is nearly round, largely darkened along the midrib and with two diffuse black crossbands; no spines, but along the margins in the laterals there is apically a row of short fine hairs; veins not visible.

Total length, including gills, 14–16 mm.; gills 3–4 mm.; abdomen 6-8 mm.; width of head 3.8 mm. One male and two female ult nymphs examined.

This conspicuously colored nymph was collected in the Surinam River near Kabelstation in the falls between Mourera-plants and fallen leaves (Sept. 21, 1938, one male and two females ult stage, one male in 3 or 4 ult stage) and in a falls of the Waremapan-creek in the Upper Litani River (July 30, 1939, one male in 3 or 4 ult stage). The nymph is a typical stream-dweller, resembling Ephemeropterid or Plecopterid nymphs by the flattened legs and by the strong broad head and thorax.

The species was not determined by breeding, but was determined by the penis of the adult male specimen, which was already developed, and by the wing venation. Mrs. Leonora K. Gloyd, who is revising the genus *Argia* and who has determined Surinam imagines, kindly informed me that *A. insipida* Hagen is the same species as *A. ierea* Geijskes described from Trinidad (Geijskes, 1932). The last name should therefore be regarded as a synonym.

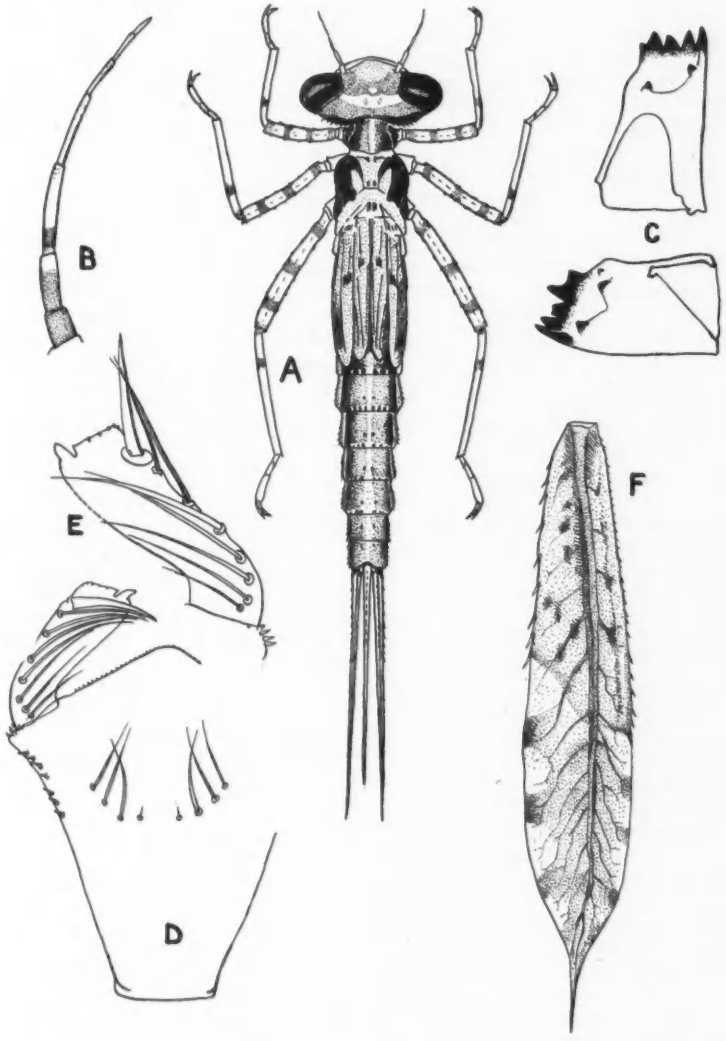
Argiallagma minutum Selys

Nymph, reared, Plate IV.

A small slender nymph with black marked body, the abdomen partly spinulose and with long acute gills.

Head more than twice as broad as long, the eyes very prominent, hind angles slightly rounded and scarcely spinulose, dark brown, with a lighter band across the vertex between the eyes, occipital border black, slightly excavated. Antennae with segment 1 dark, 2 dark with the apical third pale, 3 pale with basal third brown, 4–7 pale; relative length of the segments 10 : 12 : 27 : 21 : 15 : 12 : 7.

Mentum broadly triangular, reaching backward to just behind the first coxae, the sides diverging, along the margin in the distal half with seven short setae; mental setae three, with a smaller one to the



Argiallagma minutum Selys. A, dorsal view of full-grown male nymph; B, right antenna; C, right and left mandibles, inner side; D, mentum, inner side; E, right lateral lobe of mentum; F, right lateral gill.

middle; median lobe prominent, the sides straight, the border finely denticulated. Lateral lobes with seven setae, movable hook well developed, end hook small, curved, separated by a notch from the terminal border, which is straight and not toothed but denticulated with five or six small spines.

Maxillae of right and left sides similar; two smaller teeth at base of the end tooth, followed by a row of eight setae and more laterally by a row of three setae; upper margin with three large teeth and eight setae below with one lateral seta.

Mandibles with five unequally sized teeth; right mandible with two teeth, left mandible with three teeth on the inner surface.

Prothorax shield-like, dark brown above with a paler middorsal stripe, sides black. Synthorax relatively small, the sides black, otherwise paler to brown; wing pads reaching to the end of abdominal segment 4. Legs pale, the femora with three darker bands and darkened at the knees; tibiae with one darker ring in the basal third. Apical end of tibiae with plumose and trident setae only.

Abdomen dark brown with lighter spots more above and with a pale middorsal stripe over the segments, tapering to the end, segments 5–10 with the lateral carina spinulose, segments 7–10 with short spines over the sides.

Male gonapophyses sharp pointed with two to four short setae, reaching to the basal third of segment 10.

Gills long lanceolate, tips very acute, nodus well marked at about midway the gill length, brownish, dotted with darker spots and in the apical half with three oblique darker bands, marked especially as three darker spots along the margins.

Length of lateral gills 4.8 mm., largest width 0.8 mm.; dorsal gill 4.2 mm. and 1.0 mm.; lateral gills with 9–10 setae at the dorsal margin and with a row of 22–25 short setae on the lateral carina and along the ventral margin. Dorsal gill with 5, 20 and 17 setae respectively on these places. Veins dull brown, scarcely branched.

Total length, including gills, 14.3 mm.; gills 4.6–4.1 mm.; abdomen 6.3 mm.; width of head 2.0 mm. One adult male nymph examined.

The specimen was collected in the 2 ult stage in a flat pool on the savanna near Zandery II along the railroad (6. II. 1942) where several imagines of this species were captured at the same time. The nymph moulted to the 1 ult stage on Feb. 20 and emerged on March 9.

The nymph of *Argiallagma minutum* Selys has been described in supposition after one female from Puerto Rico by Garcia-Diaz (1938). The Surinam example corresponds very well with the Puerto Rican specimen, so that there is no doubt concerning the determination of the species. The only differences are: four mental setae (P. R.) instead of three mental setae and a smaller one against the middle (S.); tibiae with no definite rings (P. R.), tibiae with definite rings (S.). In general the length of the Surinam specimen is greater.

The genus *Argiallagma* is characterized by its wing venation, and especially by the long spines on the tibiae in the imago. For this reason the genus is generally placed near *Argia* and its relatives (*Onychargia*, *Palaiargia*, *Diargia* and *Hyponeura*) which also have long spines on the

tibiae in contrast with the other Coenagrionidae. However if we consider the structure of the nymph of *Argiallagma*, it is evident that it has very little in common with that of *Argia* as far as known (nymphs of the other mentioned genera are not known), but shows close relation with *Aeolagrion* and to a less degree with *Telebasis*. Its systematic position near *Argia* on account of the long leg spines in the imago is also not justified by the nymphal structure and must be regarded as a case of convergence.

Telebasis sanguinalis Calvert (1909)

Nymph (hitherto unknown), reared, Plate V.

A moderately slender nymph with a long abdomen and relatively short gills. Living colors green or dull dark brown with no definite darker markings.

Head twice as broad as long and wider than the succeeding parts of the body. Eyes prominent, hind angles rounded and spinulose; occipital border slightly excavated. Antennae about as long as head, 7-segmented, the two basal segments darker, otherwise pale; relative length of the segments 10 : 16 : 25 : 18 : 13.5 : 9 : 6.5. Mentum broadly triangular, reaching backward to between the first and middle coxae, the sides diverging, distally with five short setae along the margin. Only one mental seta and three smaller spines below each side. Median lobe prominent, the border finely denticulated. Lateral lobes with six setae, movable hook long, end hook well developed, separated from the finely denticulated terminal border by a deep cleft.

Maxillae with two smaller teeth at base of end tooth, followed by a row of eight setae and more laterally by a row of four setae. Upper inner margin with three large teeth and six to seven setae below with one lateral seta. Left and right maxilla the same.

Mandibules with five unequally sized teeth, right mandible with a denticle at base of largest lower dent and a knob along the upper inner margin; left mandible as in right mandible, but with two supplementary teeth or knobs on inner surface.

Prothorax shield-like, hind margin somewhat convex. Synthorax small, wing pads reaching to the beginning of abdominal segment 4. Legs pale, femora with one darker ring at the apical end, covered with some simple spines in the middle of inner side and with divided (trident) and plumose setae at end; tarsi with plumose and simple setae only.

Abdomen long and slender, slowly tapering to the end; segments 6–10 with a row of short spines on the hind margin and with some scattered setae on the sides on segments 7–10.

Gonapophyses of female extending to slightly beyond apex of segment 10, outer pair with five short spines and a few setae on ventral margin, apex long, conical. Gonapophyses of male short, reaching to the basal third of segment 10, sharp pointed with three or four short spines on the ventral side.

Gills lanceolate, about as long as the last five abdominal segments,

widest in the apical third, apex very acute; lateral ones with 22–25 ventral and with 25–26 lateral and 7 dorsal spines in the basal half. Middorsal gill with 16 ventral, 16 lateral, and 4 dorsal spines. Length of lateral gills 4.4 mm.; largest width 1.07 mm., median gill 4.50 mm., largest width 1.23 mm. Nodus not well marked at two-thirds the total length. Membrane with many branched and darkly pigmented veins, three darker spots on the ventral margin in the distal half and two such spots on the dorsal margin in the basal half.

Total length, including gills, 12.5–15.5 mm.; gills 4.5 mm.; abdomen 5–7 mm.; width of head 2.75–3.0 mm. Three males and one female examined.

Along the railroad near Zandery II (km. 62), several nymphs were found between the stems of an Heleocharis in a flat savanna pool, where young imagines of this species were commonly observed at the same time (6. II. 1942). Three males and two females were reared from this material a few days later.

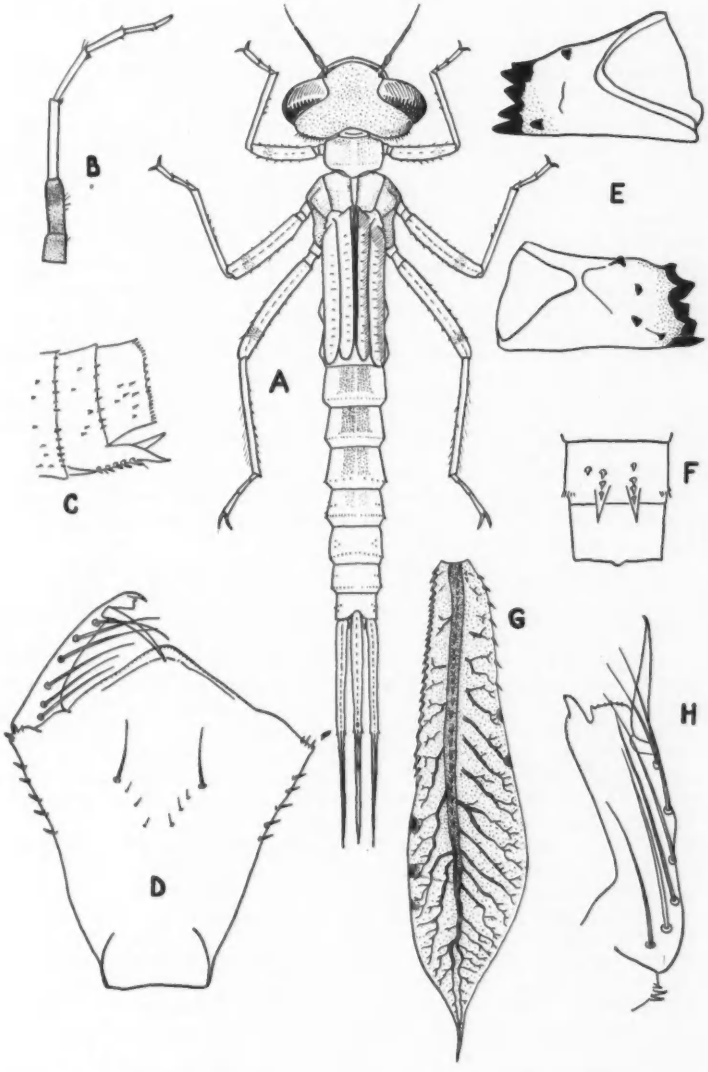
Nymphs of the genus *Telebasis* were described first by Needham (1904) from bred specimens of *T. salva* Hagen collected at Shovel Mountain, Texas. The nymph of a second species, *T. dominicanum* Selys, was described in supposition by Klots (1932) in the opinion that it was the same as that described by Needham (1904, p. 718) as *Leptobasis* sp. Garcia-Diaz (1938) thinks, however, that this nymph is really *Enallagma coecum* Hagen. This same author (*l. c.*) gives a description of the nymph of *Telebasis vulnerata* Hagen from the cast skin of a single reared female specimen from Puerto Rico.

Only two species of *Telebasis* are known without doubt in the nymphal stage, *T. salva* Hagen and *T. vulnerata* Hagen. The third species, *T. sanguinalis* Calvert (described above) differs from the other two as follows:

T. salva	*T. vulnerata*	*T. sanguinalis*
mental setae 3[2]	mental setae 3	mental setae 1
lat. setae 4–5[2]	lat. setae 6 (7)	lat. setae 6
	second antennal segment with small distal dark spot	first and second antennal segments more darkly pigmented
	Femora with two darker rings	Femora with one darker ring
	Abd. segm. 4–8 with spines on the lateral keels	Abd. segm. 4–8 with no spines on the lateral keels

It is noteworthy that the nymph of *T. vulnerata* shows close relationship with that of *Pyrrhosoma*, and the nymph of *T. sanguinalis* most with that of *Ceriagrion* of the Old World.

[2]After Klots (1932); not mentioned in the original description of Needham.



Telebasis sanguinalis Calvert. A, dorsal view of full-grown male nymph; B, right antenna; C, end of abdomen of female, left lateral view; D, mentum, inner side; E, right and left mandibles, inner side; F, end of abdomen of male, ventral view; G, left lateral gill; H, right lateral lobe of mentum.

Acanthagrion adustum Williamson (1916)

Nymph (hitherto unknown), reared, Plate VI.

A small slender nymph with the gills as long as the abdomen. Living colors pale green with a fine middorsal black line, adult brownish.

Head broader than long, widest across the eyes, the eyes prominent and each eye with 5 dotted black stripes, the fourth stripe elevating the eye margin. Hind angles well developed, truncated, the outer corner spinulose, occipital border slightly excavated.

Antennae longer than head, 6-segmented with an indication of a seventh segment; pale, the basal segment and upper part of segment 2 darker and richly bristled. Relative length of the segments 19 : 22 : 28 : 20 : 11 : 12 (8 : 4). Labium broadly triangular, reaching backward to the middle coxae, the sides diverging, the distal inner half of each side with a row of six or seven small short setae. Only one mental seta on each side. Median lobe very prominent, uncleft, the border finely denticulated. Lateral lobes armed with four setae, movable hook large, end hook strong and curved downward; terminal border with four dents, the first and the last one respectively with the tips trifid and bifid.

Maxillae: left and right maxilla of the same structure. End hook large, with three smaller dents on its base, followed by six larger and six smaller setae below; upper margin with three large teeth, followed by six marginal and one lateral seta.

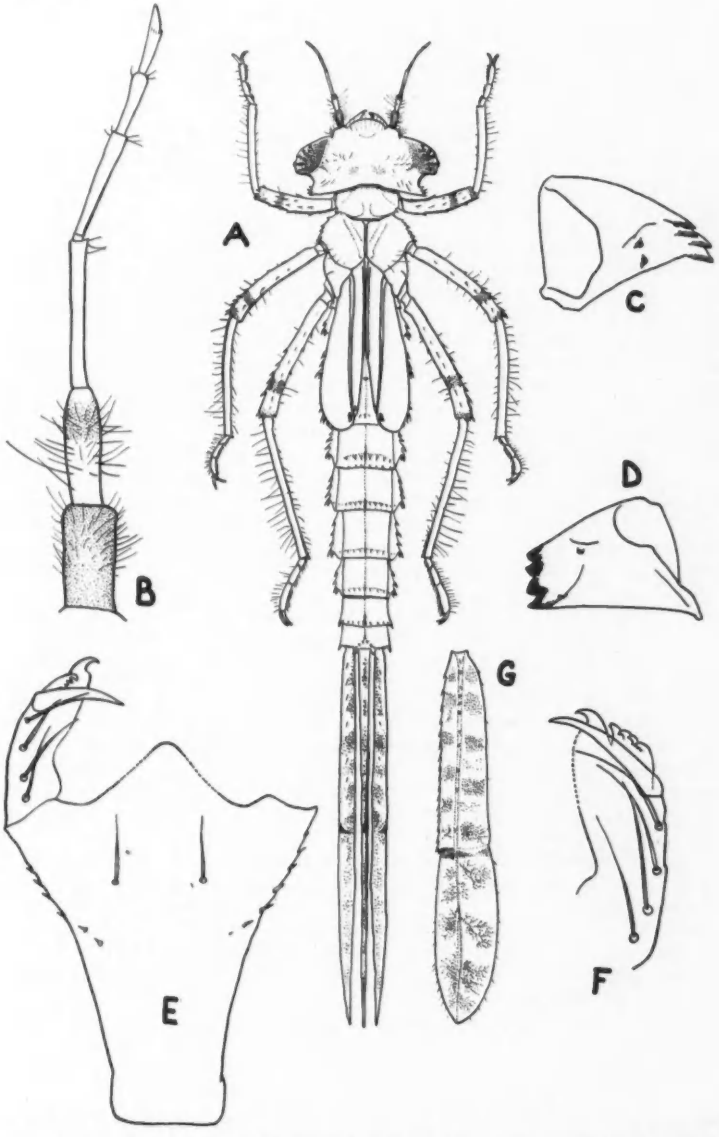
Mandibles with four unequally sized teeth, right mandible with a denticle at base of the largest dent and two teeth on the inner side, left mandible with one median and one marginal tooth on the inner side.

Hind lobes of prothorax and front margins of synthorax with a row of short spines. Wing pads reaching to anterior margin of abdominal segment 5. Legs pale, the femora with a darker ring in the apical half and at the apical end, covered with some rows of short spines and a few long fine hairs. Tibiae with many long fine hairs and with divided (trident) setae and some plumose setae at the apical end. Tarsi with plumose setae along the inner margin and with finer simple hairs on the outer side.

Abdomen cylindrical, tapering to the end. Lateral keel of segments 1–8 flattened and armed with five short spines. A fine black middorsal line over all the segments; ventral side pale with a black midventral spot on the hind margin of the segments.

Gonapophyses of female long, reaching to apex of segment 10; outer pair somewhat longer than inner pair, ventral margin of outer pair with a few hairs and with two short spines, apex long (about one-third the length of the gonapophyses), conical. Gonapophyses of male short, straight, sharp-pointed, directed caudad to middle of segment 10.

Gills very long and lanceolate, as long as the abdomen, apex acute; ventral margin in the basal half armed with a row of 18–19 short spines, dorsal margin with a few long hairs. Nodus indicated by a small constriction at about half the length of the gill, darkened



Acanthagrion adustum Williamson. A, dorsal view of full-grown female nymph; B, right antenna; C, left mandible; D, right mandible; E, mentum, inner side; F, right lateral lobe of mentum; G, left lateral gill.

below. Membrane with many pigmented areas, forming about 10 crossbands.

Total length, including gills, 18–20 mm., abdomen 6.5–7.0 mm., gills 6.5–7.0 mm., hind femur 2.5 mm. One male and one female examined.

Two nymphs of this species were found at Zandery I (27. V. 1941) in a small partly widened creek along the railroad in the savanna, where they were dredged from between the water plants (*Cabomba aquatica* Aubl.).

From the male nymph the imago appeared on June 1. No imagines have been observed at the collecting place. The reared male belongs to the darker form of the species, differing from the common color pattern as follows: nasus entirely black, post ocular spots blue, middle lobe of prothorax black without orange spots, synthorax above clear blue, not orange or reddish brown; a black spot on the second lateral suture, about one-half the width of the dorsal black stripe, reaching the metastigma. Segment 8 with basal two-thirds of dorsum black, dorsum of segment 10 black except blue hind margin. The morphological details, as penis and appendages, however, fully agree with the typical *adustum*, which has been collected near Zandery and Republiek.

This nymph greatly resembles the described *Acanthagrion* specimen from Brazil, Rio Grande Do Norte, Forêt d'Utinga 11. XII. 1935 (Cowley, 1939), but differs from it in the less excavated hind margin of the head, the spinulose front margin of the synthorax, and in the number and arrangement of hairs and dents on the maxillae (gills are lacking in the Brazilian specimen.)

Acanthagrion indefensum Williamson (1916)

Nymph (hitherto unknown), reared, Plate VII.

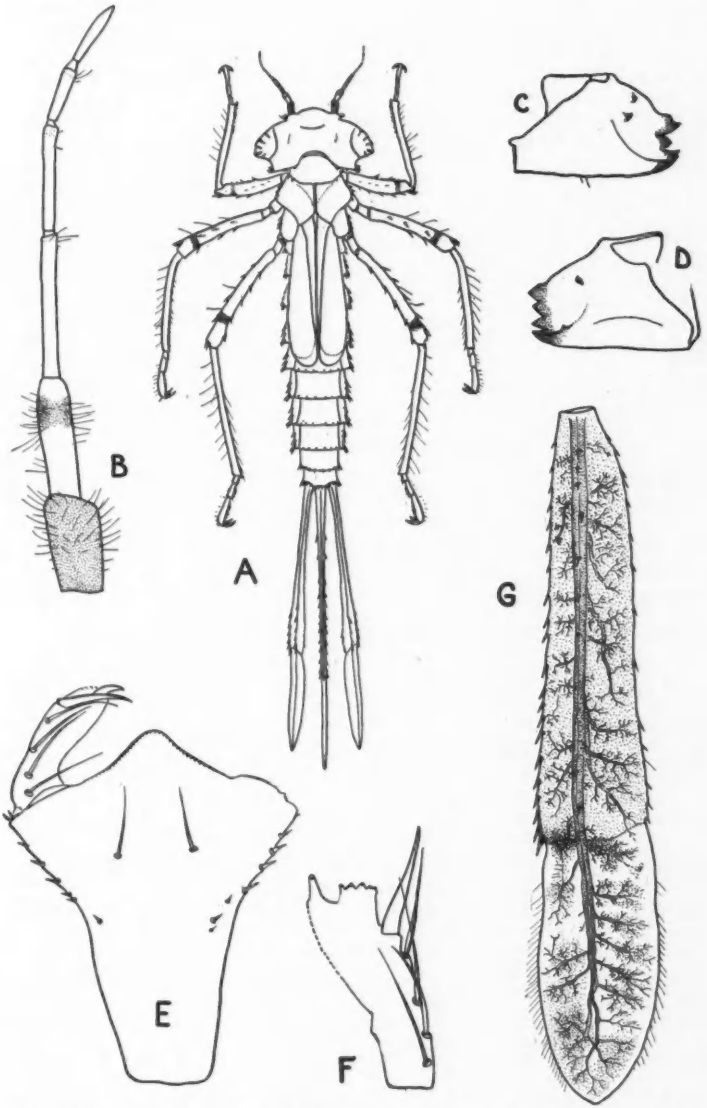
The nymph of this species is very similar to those of *A. adustum*, differing only in the following points:

Living colors green, with no darker markings. Antennae as long as or slightly longer than head, 6-segmented, the basal segment and upper end of segment 2 darker and bristled, otherwise pale and practically unbristled. Relative length of the segments 18 : 21 : 26 : 19: :11 : 13.

Left maxilla with two small dents at base of end tooth, followed by five larger and seven smaller setae below; upper margin with three equally sized large teeth, followed by seven finer setae below; right maxilla, end tooth with two smaller basal teeth followed by four larger and eight more laterally situated setae; upper margin with three large equally sized teeth, followed by four longer setae and two smaller laterals.

Abdomen segments 5–10 with the hind margin dorsally spinulose; ventral margin of outer pair of female gonapophyses with four short spines, apex long (about one-third the length of the gonapophysis), conical, and sharp pointed.

Gills very long and lanceolate, as long as abdomen, with the apex nearly rounded; nodus at three-fifths the total length, well indicated; margin ventral to the nodus armed with a row of about 20 short



Acanthagrion indefensum Williamson. A, dorsal view of full-grown female nymph; B, right antenna; C, left mandible; D, right mandible; E, mentum, inner side; F, right lateral lobe of mentum; G, left lateral gill.

spines, those on the nodus the largest; dorsal margin with about 15 finer setae. Sides of the gill apically to the nodus with a row of longer hairs. Membrane with many finely branched parts of the tracheal veins, which are more or less pigmented, but forming no distinct darker crossbands.

Total length, including gills, female 14–16 mm.; abdomen 5.5 mm.; gills 6 mm. One female nymph and one female exuvia examined.

Beside its smaller size, the nymph of this species is best characterized by the position of the nodus in the gill, situated in *adustum* at about one-half the length, in *indefensum* at three-fifths the length of the gill.

The specimens were collected at the same place as those of *A. adustum* on June 18, 1941. One of the females was reared, and emerged June 28.

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LIFE HISTORY NOTES ON MICRATHYRIA
(Odonata)

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The nymphs of four species of this little known genus have recently come to hand. One of them, *M. hageni*, occurs within the limits of the United States. All four are West Indian, and all were reared by me during recent visits to these islands. The nymph of *M. dissocians* was well described and figured by Dr. Elsie Broughton Klots in her report on the Odonata of Puerto Rico of 1932, from specimens that I collected on the island in 1930. I wish to note at the outset that hers is the first description of a nymph of this genus; for the Brazilian nymph that I described in 1904 (Proc. U. S. Nat. Mus. 27: 211) along with the adult reared from it as "*Micrathyria pallida*" n. sp. has been found to belong in the closely related genus *Erythrodiplax*.[1] I reared nymphs of *M. aequalis* in Cuba in 1937, and of *M. didyma* and *M. hageni* in Santo Domingo in 1940; these I now wish to describe and differentiate by means of keys. I will also add a few observations on the very unusual egg-laying habits of *M. aequalis*.

The adults of these species are readily distinguishable by the key furnished by Dr. Klots in her 1932 paper; the nymphs may be distinguished as follows:

A KEY TO THE KNOWN NYMPHS OF MICRATHYRIA

1. Venter of abdomen pale, marked with a double row of brown dots or dashes...2
   Venter of abdomen obscure, without obvious pattern.....3
2. These markings minute round dots; lateral labial setae nine or ten...**aequalis**
   These markings larger transverse dashes; lateral labial setae eleven or twelve.....**didyma**
3. Abdomen on the dorsal side pale basally, blackish beyond the middle...**hageni**
   Abdomen clouded, with a pair of submedian bands of brown.....**dissocians**

Micrathyria hageni

I begin with this species because of special personal interest in finding it. I tried to find it in Texas where it is recorded from the Rio Grande region. I got it in Santo Domingo, but only by collecting two nymphs and rearing one of them.

The place was a beautiful mountain pond near El Llano on the road to Puerto Plata across the northern coast range. The pond has a charming setting among green hills, with steeply rising grassy slopes and tree-crowned summits all around it. The water is clear (though it is in a pasture), and too deep for wading except near shore. The emergent vegetation is scanty, and the submerged water weeds are not

[1]Dr. Fr. Ris (Libellulinae, de Selys Coll., p. 511) regarded my *M. pallida* as a synonym of *Erythrodiplax chloropleura;* but Dr. D. J. Borror, in a more recent study of the genus Erythrodiplax has restored it to good specific standing in that genus.

too thick for effective use of nets. It is a small pond, only a stone-throw wide, and but little longer. It is easy of access by a short walk from the road, but not visible from the roadway. It lies close to the top of the north range on the seaward side.

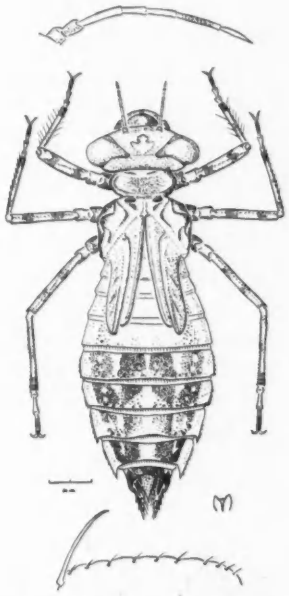
This pond was fairly swarming with dragonflies of many kinds. Most conspicuous was the big red *Tramea abdominalis*. Adults of this species were in the air everywhere, their cast skins besprinkled the shore line, and living nymphs swarmed in the weed beds. Three other ubiquitous skimmers were common enough: *Orthemis ferruginea*, *Pantala flavescens* and *Erythrodiplax umbrata*. But *Micrathyria hageni* was very scarce, and the explanation of that scarcity probably lay in the abundance of the nymphs of these larger predators. In an hour and a half of collecting I took Tramea nymphs by the hundreds, while of the Micrathyrias I got but two.

I did not discover that I had taken the nymph of Micrathyria until after I had left the pond, and I came by my reared specimen very unexpectedly. Dr. Julio Garcia Diaz was with me; the afternoon was waning; we were to be with friends in Santiago for dinner in the evening. We were hastening to make as complete a catch as possible in the limited time available. I plied my apron-net in the water, and dumped the unassorted catch of hundreds of specimens into a pail, and carried it back to our hotel in Santiago. Arrived there I noticed that one odd looking little black nymph was trying to climb up the side of the pail. Having a pillow cage handy, I put that nymph into the cage and set the cage back in the water. While I was dressing for dinner the adult emerged and expanded its wings. I put it into a paper bag to mature its colors and then went to dinner. The next morning I found I had a finely colored adult *M. hageni*, together with the whole cast skin from which it had emerged. The following description is based in part on that cast skin and in part also on a half grown nymph found later among the specimens in my pail.

The nymph measures 17 mm. in length; abdomen 12; hind femur 5; width of head 5, of abdomen 6.

This is a smooth greenish nymph, heavily marked with brown as follows: On the head is a mottled pattern; on the sides of the thorax a broad diffuse lateral band extends down over the leg bases and a dash of brown lies across the prothoracic dorsum. The wing cases when well grown are heavily washed with brown. The legs are mostly pale, with two rings of brown on the femora, three on the tibiae and a broader one on the last segment of the tarsi. There is on the sides a crescentic streak of brown under the base of each wing sheath. The abdomen is more or less suffused with brown; lightly on its basal half, and heavily from segment 5 to the end, but with an ill-defined and paler middorsal stripe, and a pale band near the lateral margin. The middle hinge of the labium extends backward to the base of the hind legs. The prominent middle lobe of the mentum is almost unarmed. There are ten lateral and twelve mental setae. The relative lengths of the seven pale antennal segments are 4 : 6 : 9 : 7 : 8 : 10 : 10, the second and sixth are heavily marked with brown.

The half grown nymph taken at the same place and time is very similar but lacks the full complement of raptorial setae, these being laterals 9, mentals 11. In both specimens the abrupt blackening of the posterior half of the abdomen is very marked.



Nymph of *Micrathyria hageni*
With enlarged antenna above, and end of lateral lobe of the labium below.

Micrathyria aequalis

This was the commonest Libelluline dragonfly present at Soledad, Cuba, in May, 1937. It swarmed about the edges of the big pond in the botanical garden and about two lesser ponds outside the garden. It is a low-flying species that does not stray far from the edge of its native pond. A bed of *Potamogeton natans* near the dam in the big pond of the garden was its favorite haunt. The seed spikes of this water-weed, rising stiffly erect out of the water for an inch or two, furnished its favorite perching places. The floating leaves of Potamogeton were selected by it for oviposition. On May 8th and 9th I made some observations on its egg-laying. The process was very different from that of any other Libelluline known to me.

The female oviposits unattended by the male. She alights on the edge of a floating leaf, squats on it crosswise with legs widely extended, and turns her abdomen downward and forward under it. Thus inverted the end of her abdomen is in proper position for sticking the eggs to

the leaf's under surface. She swings her body from side to side, plastering her eggs to the leaf in rather irregular rows and in a single layer, and leaving them there to hatch. From one position on the edge of a leaf the female is able to reach about half way across it. On about a square inch of one side of one leaf I counted and estimated about 2000 eggs. These may have been laid by more than one female; for she may move from leaf to leaf, and there may be repeating. However one female operating on a fresh leaf for about a minute laid 184 eggs by actual count, and then went elsewhere to continue laying.

Males hover around and sometimes interfere. I saw one male settle on the back of a busily ovipositing female. He took her by the top of the head with his claspers, and they flew away together. They remained together only for a moment, and she returned again to lay some more eggs.

I reared a nymph on May 7th, obtaining a fine male adult specimen. With its cast skin for guidance I was able to identify other nymphs which I collected in great abundance from a little pond back of Mr. Gray's residence just outside the garden.

The nymph measures in length 17 mm.; abdomen 9; hind femur 5; width of head 5, of abdomen 6.

This is a very pale, almost unpigmented nymph, blackish only on the eyes, on a band running inward from the front of the eye, and two streaks running inward from its inner hind angle. There is a faint mottling of the upper surface on the head and a faint longitudinal middorsal band on the prothorax. The antennae are pale except for the brown suffusing segments 1, 2, and 6. The legs show very faintly the usual cross banding and very conspicuously a fringe of long thin hairs.

The dorsum of the body is faintly besprinkled with pale brown prickles, that are most evident on the abdomen. There is a pair of roundish areas bare of these prickles on each abdominal segment with a little brown dot at the rear margin of each, and there is a similar bare patch at the front on each lateral margin.

The labium is armed with ten lateral and fourteen or fifteen mental setae. The lateral spines of the 9th abdominal segment are as long as that segment is on the middorsal line and the spines of 8 are but little shorter. The lateral appendages of the abdomen are about half as long as the inferiors and the superior is a little longer than the laterals. Segment 10 is narrowed almost to nothing on the middorsal line.

Micrathyria didyma

I collected both adults and nymphs of this species from the little weedy spring-fed brook that flows down Arroyo Sabana Miguel, near San José de las Matas, Santo Domingo. It was associated there with *Dythemis rufinervis*, *Cannaphila funerea*, *Lestes spumarius*, *Leptobasis vacillans*, and others. I got a number of nymphs by raking the bed of the streamlet with a little sampling net, and I reared two of them, a male and a female. The dates were June 21st and 22nd.

The nymph measures in length 18 mm.; abdomen 12; hind femur 5; width of head 5, of abdomen 6.

This is a blackish nymph, with the skin everywhere heavily besprinkled with dark granulations that are coarser than in the other species, and approach solid blackness on the end of the abdomen. The pale antennae are broadly marked with blackish at the juncture of the two basal segments and on the middle of the third and sixth. The frons is brown, fenestrate with transverse streakings of paler color. On the rear of the head seven scurfy-pubescent longitudinal streaks of brown extend down the declivity of the occiput. The usual median longitudinal band of brown on pro- and mesothorax is narrowly divided by paler color.

The labium is armed with twelve lateral and fourteen mental setae. The lateral spine on the 9th abdominal segment is shorter than the middorsal length of that segment, and the spine on 8 is shorter still. The inferior abdominal appendages are very long and sharp (longer than 9 plus 10 middorsally); the laterals are a little less than half, the superior is a little more than half as long as the inferiors.

MEDICAL PARASITOLOGY, by JAMES T. CULBERTSON. Pages xvi and 285, 16 figs., 22 full-page plates, 6 x 9 inches. Published by COLUMBIA UNIVERSITY PRESS, Morningside Heights, New York. 1942. Price, $4.25.

In the preface to his book the author advises us that changing circumstances of modern times require that medical schools should give more instruction on the causes of parasitic diseases. Modern travel, business and the global war all enhance the possibility of spread of these infections into new areas. Professor Culbertson feels that our greatest hope of protection against these diseases is the dissemination of knowledge of the agents which cause them. His text carries this information to the medical student and physician. Its organization, manufacture and style are excellent. The reader gains a complete picture of the dynamic side of medical parasitology without being troubled by a mass of morphological and taxonomic details.

The text is written in two parts. Part One, General Considerations, is a masterful presentation of general information about parasitism. It seems to us that the strength of the book lies in this part. Part Two, Infections Caused by Animal Parasites, is a brief description of protozoan, helminth and arthropod parasites and the diseases caused by them. The emphasis in this section is placed upon the medical aspects of infections: methods of infection, symptoms, treatment and prevention. A short section on technical methods and references follows this part. The illustrations consist of photographs.

Two chapters are devoted to arthropods, one of 23 pages to insects and the other of 10 pages to arachnids, crustaceans and myriapods. Entomologists may find the treatment of these chapters somewhat disappointing, since keys, morphological descriptions and citations to literature are reduced to a minimum. However, we feel that the author has exercised good judgment in keeping his text simple for readers with a limited background in taxonomy and morphology.

—WILBUR M. TIDD.

A DRAGONFLY NYMPH DESIGN ON INDIAN POTTERY

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In the U. S. Navy report to the 33rd Congress (1855), entitled "The U. S. Naval Astronomical Expedition to the Southern Hemisphere during the years 1849–1852," Vol. II, we find an article by Thomas Ewbank which bears the heading "Appendix E. A Description of the Indian Antiquities Brought from Chili and Peru by the United States Naval Astronomical Expedition." On page 130 Ewbank figures an Indian bowl or deep plate with a decorative design in which the zygopterous nymph is used as the motif. In the page of figures this item is lettered S.

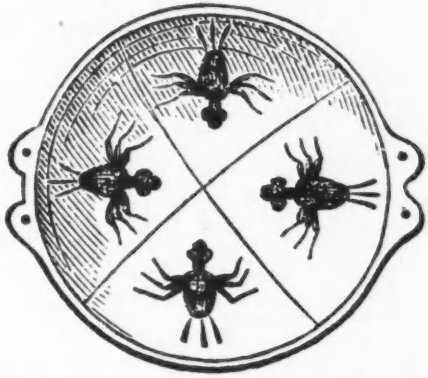
Ewbank (p. 132) writes as follows: "Figures s-y are specimens of thirteen plates or shallow pipkins, varying from three to thirteen inches across, and rarely exceeding half an inch in depth. Most have handles, terminating with the head of a bird, etc. All are ornamented within, none without. The colors are black, red, white, and yellow. Except such as have recurved or ring-shaped handles, all have studs at the rims; and some of these projections have small perforations, probably to insert loops of twine to suspend them against the walls, instead of resting them on shelves. Those marked s, t, were found in 1820 in a huaca (grave) near Saint Sebastian, one league from Cuzco."

The region is Incan but pottery from a burial might be pre-incan. The history of the Inca Empire is well known: at the time of the Spanish conquest it had been rather recently organized from several Andean tribes. The history of its tribes previous to the Empire, their origins and wanderings are more obscure. Cuzco was an Incan metropolis but its environs might have had previous cultures.

The design on this dish is the first instance we have found of a dragonfly nymph used as the motif in a repetitious design. Ewbank states that "figures s-y are thirteen plates varying from three to thirteen inches across." If all items have the same reduction, the plate or bowl (fig. s) with dragonfly nymphs is ten to twelve inches in diameter. The colors of this particular design are not given. The material collected by the Astronomical Expedition was deposited in the Smithsonian Institution and may be still there.

The creature from which the design was drawn is obviously a six-legged Arthropod, and because the three caudal appendages widen apically and it has large eyes it is probably a zygopterous nymph. If the three caudal appendages (gills) had been broad at the base and narrowed apically, it could have been an ephemerid nymph with appressed lateral gills. I do not know any zygopterous nymph with such a broad and short body but the nymphs of the Andean fauna are little known. If it had paired lateral abdominal gills it could be thorine, and might be such, as the paired gills of thorine nymphs are as

much under the sides of the abdomen as projecting beyond the sides. They might not be conspicuous from above in this species. Without lateral gills the next best assumption is that it may have been a very short Argia. Some of the nymphs in this genus are the shortest bodied nymphs of which we know at present. The crab-like sprawl suggests an inhabitant of swift mountain streams where to face the current the body lies tight on the rocky bottom. Swift water is further suggested in the wide horizontal spread of the legs which permits the tarsal claws to be deeply anchored in the substratum. It also lays the legs themselves flat on the bottom where least vibration from swift water can occur. Further yet the femora are very wide, probably streamlined in cross-section. The last is a character of swift-stream mayfly or stonefly nymphs rather than of dragonfly nymphs.



Indian bowl with dragonfly nymphs. From grave near Cuzco, Peru. From Ewbank, 1855.

The question arises, why should a small obscurely colored water insect interest an artist-potter? I have no answer. In this connection of dragonflies as an art motif with Indian designers is the article by Hugh G. Rodeck, 1932, these ANNALS, 25: 688–690, 2 pls. In a hasty survey I have run across the butterfly in a very conventionalized form used in a repeating design on Indian pottery from the Pecos Valley, New Mexico. The reference is to d of fig. 34, p. 87, and fig. 33, p. 86, vol. I of "The Pottery of Pecos" by Kidder and Amsden, 1931, Phillips Academy Publication, Andover, Mass.

THE NEARCTIC SPECIES OF PARASITIC FLIES BELONGING TO ZENILLIA AND ALLIED GENERA, by WENDELL F. SELLERS. Published in Proc. U. S. Nat. Mus. 93: 1–108 (no illustrations). Paper bound. 1943.

This paper revises the genera Zenillia, Phryxe, Carcelia, Aplomya, Sisyropa, Thelymyia and a new genus, Angusta. It contains a few extra-limital species and another new genus, Chrysophryxe (Brazil). It has no illustrations.—C. H. K.

ON THE NYSSORHYNCHUS COMPLEX

(Diptera: Culicidae)

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The utmost caution is requisite to success in dealing with the members of the Nyssorhynchus complex. There are thirty-five names that have so far been applied to them; these are listed below in alphabetical order.

albimanus Wd. 1821
albipes Th. 1901
albitarsis LA 1878
allopha LP 1921
anomalophyllus Komp 1936
aquacelestis Curry 1932
aquasalis Curry 1932
argyritarsis RD 1827
bachmanni Petr. 1925
brasiliensis Chagas 1907
cubensis Agr. 1900
cuyabensis NP 1923
darlingi Root 1926
davisi PS 1927
dubius Bl. 1905
emilianus Komp 1941
evansi Brethes 1926
goeldii RG 1941
gorgasi DK 1907
ininii SA 1938
lanei CA 1938
limai GL 1937
metcalfi GL 1938
noroestensis GL 1938
nuneztovari Gab. 1940
oswaldoi Per. 1922
paulistensis GLC 1937
perezi SP 1928
pessoai GL 1937
rangeli GGL 1940
rondoni NP 1922
rooti Brethes 1926
strodei Root 1926
triannulatus NP 1922

There may be synonyms among the above names, but any one of them may be needed at some future time if it can be definitely placed by means of type specimens. The name *tarsimaculatus* Gld. is omitted because it equals ***albipes*** Th. independently of types.

It is useless to accept synonymy in this complex before every last character both morphologic and physiologic of all stages has been exhaustively compared and found to be identical. Thus ***bachmanni*** may easily prove distinct from ***triannulatus***, ***aquacelestis*** is not likely to be ***oswaldoi***, ***gorgasi*** and even ***albipes*** may prove distinct from ***albimanus***, ***evansi*** and ***rooti*** or even ***cubensis*** and ***dubius*** may prove valid.

Goeldi's and Dashkow's (Galvao and Lane, 1938, p. 173; Rozeboom and Gabaldon, 1941, p. 92) forms are not yet definitely placed.

Rozeboom (1941) gave a most useful compilation of what is known regarding the Caribbean anophelines. Rozeboom and Gabaldon (1941) gave a summary of the Nyssorhynchus complex and named the lower Tapajós form ***goeldii***. Komp (1941) named the present dominant Belém form ***emilianus***. Komp's article calls for the following comments.

We were well equipped on the Tapajós in 1932–1933 for dealing with the taxonomy of the Culicidae except that the work was cut short before completion (Townsend, 1934, p. 495), and we found there a virgin field

for investigation. Shannon had spent a week there the year before (June 14–20, 1931) and found *darlingi*, *albitarsis*, *goeldii* (which he called *tarsimaculatus*) and *bachmanni*. We found the same four forms and also *brasiliensis*, only these five being positively distinguished in numbers of adults, and *goeldii* being identified with query as *oswaldoi*. But we also found a few adults of what seemed to be *albimanus*, and these with larvae were so identified with query, while it was stated that the males might not belong to the females. Referring to our original notes made at the time on the Tapajós, the material doubtfully determined by us as *albimanus* comprised two males reared June 23 and July 4 from open ground pools; seven females on horse August 8–12; seventy larvae July 20 to August 7 from exposed river margin grass and ground pools, agreeing with *albimanus* characters. The mounts of the terminalia of the two males were accidentally spoiled and the June 23 one was discarded, the July 4 one being retained because it was the only remaining specimen. Thus only one mount should be in the U. S. National Museum, and that was or should have been labelled *albimanus* with query. No positive determination can be made from that mount. On tarsal coloration the males did not fully agree with the females, but both agreed on wing coloration and other characters. Stone determined this material as *gorgasi* with query. Pinto did not report on the July 4 male (lacking terminalia) and a female sent to him.

An *albimanus* race is definitely known to be present in Venezuela (Rozeboom, 1941, p. 100) and should therefore be present in Brazil. Theobald and Grabham (1905, p. 15) recorded as *albipes* what was probably this race from British Guiana and Brazil. Theobald positively determined Goeldi's material in a long series of this race as *albimanus*. There is no reason why this race of *albimanus* should not have extended down the coast of the Guianas and Brazil (Lane, 1939) to Belém forty years ago. It will be strange indeed if it be not yet found in the Amazonian region. Changed environment may easily have exterminated it at Belém. *N. albitarsis* was present at Belém forty years ago, as shown by Goeldi's data. It is not present there now, but is present on the Tapajós.

There is no possibility that *emilianus* is Goeldi's form. Goeldi's egg figure could not have been made from a shrivelled or distorted *emilianus* egg. The habits also disagree, since *emilianus* does not frequent houses even in the immediate vicinity of its breeding places and prefers horse to human blood. The description and identification of *emilianus* are of much interest as fixing the present dominant form heretofore confused with *oswaldoi* at Belém but it can not be the form with which Goeldi worked. Nor can *goeldii*, the present dominant *oswaldoi*-like form on the Tapajós, be his species, since the adult habits of *goeldii* are the same as those of *emilianus*. The larval habits of the two are contrasted, *emilianus* breeding in sunlit pools and *goeldii* in more shaded pools and river margins.

We must look to the Theobald Collection for the male terminalia of Goeldi's form, which should be closely allied to *albimanus*. This dictum may plunge the subject into greater confusion for the moment, but clarity will eventually emerge from this confusion.

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Komp, W. H. W. 1941. The species of Nyssorhynchus confused under *tarsimaculatus* Goeldi and a new name, *A. emilianus*, for one species found in Pará, Brazil. Ann. Ent. Soc. Amer., 34: 791–807.

Lane, J. 1939. Catologo dos mosquitos neotropicos. Bol. Biologico, Serie Monografica, No. 1, 218 pp. See pages 20 and 21 for nine further records of *albimanus* in Brazil; not all of the nine can be misidentifications!

Rozeboom, L. E. 1941. Distribution and ecology of the Anopheles mosquitoes of the Caribbean region. Amer. Assn. for the Advancement of Science, Pub. No. 15, pp. 98–107.

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Theobald, F. V., and **Grabham, M.** 1905. The mosquitoes or Culicidae of Jamaica. Institute of Jamaica, pp. 1–40; 9 pls.

Townsend, C. H. T. 1934. Mosquitoes of the Rio Tapajós. Revista de Ent., 4: 486–499.

THE DUCKS, GEESE AND SWANS OF NORTH AMERICA. A vade mecum for the Naturalist and Sportsman. By FRANCIS H. KORTRIGHT, the illustrations by T. M. SHORTT. Pages viii+476, over 200 text figures, and 36 colored plates. 6x9 inches. Published by THE AMERICAN WILDLIFE INSTITUTE, Washington, D. C. Price, $4.50.

This is one of the outstanding bird books, written for the layman, to appear in recent years. Written by a Canadian sportsman, it is dedicated to the Sportsmen Gunners and Naturalists of Canada and the United States, and should go far in promoting the conservation of waterfowl.

The first 64 pages of the book contain general information about waterfowl: family and subfamily characters, duck topography, a glossary, scientific nomenclature (teachers of entomology will like this section), moults and plumages, identification, determination of sex and age, mating and nesting habits, feeding habits, longevity, flight speed, hybridism, botulism and lead poisoning, migration routes and banding (by Frederick C. Lincoln), conservation (by Ira N. Gabrielson), and other water birds. Pages 65–379 contain "Descriptions, Identifications and Life Stories of the Ducks, Geese and Swans." Each of the 61 species and subspecies occurring in North America is discussed in considerable detail: the pronunciation and derivation of the scientific name, colloquial names, a detailed description of both sexes and all plumages, means of identifying specimens, field marks (on the water, in flight, and voice), and a "life story." The latter contains a discussion of the feeding, courtship, nesting, and other habits of the species, its range and migration, and its status as a game bird. Additional sections of the book deal with weights and measurements, bibliography, acknowledgments, index, and the color plates.

The illustrations in this book are superb. There is a distribution map for each species showing the principal breeding and winter ranges, over 200 line drawings in the text, and 36 color plates in the back of the book. The line drawings illustrate all the important structural characters of the various species and groups, and the appearance of each species on the water and in flight. The color plates illustrate all the plumages—adults in winter and breeding plumage, eclipse and autumn plumages, and the downy young. Each color drawing of a bird shows it in a standing position, and hence shows the underparts and feet. With each drawing of an adult bird is a drawing of its spread wing, a feature usually not included in most waterfowl plates. There is one plate of duck hybrids. The explanation of each plate includes not only a key to the figures, but often contains a discussion of the figures and a summary of the distinguishing characters of the species illustrated, and contains references to other color plates and the text pages dealing with the species. The illustrations in this book establish Mr. Shortt as one of the outstanding bird artists on the continent.

This book is one which not only every sportsman, but every naturalist, ornithologist, and bird enthusiast should possess. It is printed on a good grade of paper and is bound to stand considerable use. The author, artist, and publishers are to be congratulated on the publication of this outstanding book.—D. J. B.

A SYNOPSIS OF THE PSOCIDS OF THE TRIBE PSYLLIPSOCINI, INCLUDING THE DESCRIPTION OF AN UNUSUAL NEW GENUS FROM ARIZONA

(Corrodentia: Empheriidae: Empheriinae)

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This paper was prompted by the discovery, in the Tucson Mountains of Arizona, of a new psocid which apparently has as its closest relative a cave-inhabiting species of western Europe. The Arizona species represents a new genus which is a noteworthy addition to our Nearctic fauna, and, because of a lack of published revisionary work, a synopsis of the tribe to which the genus belongs has been prepared. One of the more interesting species of Psyllipsocini is *Psyllipsocus ramburii* Selys, which occurs in houses both in Europe and the United States, and which is dimorphic, both short-winged and long-winged individuals being found in the same colony. The European genus *Prionoglaris* Enderlein, which is closely related to the new Arizona genus, is unusual among pscoids in the lack of a lacinia in the adult, and a section devoted to mouth parts, especially those of these two genera, follows the main taxonomic part of the paper.

I am greatly indebted to R. A. Flock, of the University of Arizona, for supplying abundant material of the new genus. The generous cooperation of P. J. Chapman, of Geneva, N. Y., and Nathan Banks, of the Museum of Comparative Zoology, in the loan of specimens of *Psyllipsocus*, is acknowledged. One new species is based on specimens collected in Yucatan by A. S. Pearse of Duke University while on an expedition sponsored by the Carnegie Institution of Washington, and I appreciate his kindness in making the material available. R. E. Snodgrass very kindly assisted in the morphological study of the mouth parts.

The important characters of the tribe Psyllipsocini are given in more detail later, but the nature of the group may be briefly indicated by listing the following outstanding characters: Tarsi three-segmented; wings without a definite sclerotized stigma or covering of scales; vein M normally forked in both wings, in front wing with three branches.[1]

Unfortunately, the classification of the higher categories of the Corrodentia is rather unsettled, but the family Empheriidae and the subfamily Empheriinae of this paper correspond to the Empheridae and Empherinae of Banks (1929), and his family and subfamily keys are useful. The latter author did not treat categories lower than subfamily, in the case of the Empheriidae, and there is need for a tribal revision. *Empheria* Hagen, the type genus of the family, is based upon a fossil,

[1]The nomenclature of the wing veins employed in this paper is after Enderlein (1927 and other papers), but it should not be assumed that all interpretations are correct until the tracheation of a member of the Psyllipsocini has been studied.

and this and several related fossil genera require study before such a revision can be accomplished. Certain fossil psocids are mentioned later, in order to give a better understanding of the group involved, but this paper is primarily concerned with recent, living species. Students will find Karny's classification (1930) helpful, since he presents an arrangement of all psocid genera then described, and his generic complex called Psyllipsocini is the same as mine, although his treatment of subfamilies and families is unlike either the previously mentioned classification by Banks or those of Enderlein (1927) and Pearman (1936).

THE TRIBE PSYLLIPSOCINI

Characters: Legs slender, tarsi three-segmented; ocelli usually present; wings fully developed or rudimentary, without a definite sclerotized stigma or covering of scales, often with some setae on veins but without extensive pubescence. Wings of long-winged specimens as follows: Venation definite and all principal veins reaching wing margin; front wing with three distinct branches of M; the cross vein between Rs and M of front wing basad of the forking of M; anal veins of front wing two in number, briefly or not at all separated at their apices and terminating in a common nodus at wing margin; hind wing normally with M forked; usually a closed cell in hind wing and one, sometimes two, closed cells in front wing.

The wing venation is distinctive, and there is little likelihood of confusion with psocids belonging to other groups. The fossil genera ***Empheria*** Hagen and ***Bebiosis*** Enderlein, both occurring in Prussian amber (see Enderlein, 1911), have a closed cell formed in the front wing by vein Sc similar to the closed cell anterior to vein R in the front wing of ***Prionoglaris***. The former genera were rather widely separated from the Psyllipsocini by Karny (1930), but I suspect that close relationship actually exists, and, if so, the group would appear to be an ancient one. This seems likely, in view of the closely related and probably long isolated genera occurring in Europe and Arizona.

Members of this group occur in both hemispheres, but none are known from the Australian Region. Several species have been found in caves, and this fact is of interest because comparatively few cave-inhabiting psocids are recorded. For lists of psocids taken in caves and for discussions of the general aspects of the faunas of caves, the reader is referred to Jeannel (1926), LeRuth (1939), Pearse (1938), and Wolf (1934).

KEY TO THE GENERA OF PSYLLIPSOCINI (BASED ON ADULTS)

1. Vein Sc of front wing fused with R for a short distance in apical half of wing so that a closed cell anterior to R is formed (figs. 14, 15), (only fully winged individuals known); segment 3 of antenna unusually long for the Corrodentia, longer than head 2
   Vein Sc of front wing not fused with R in such a way as to make a closed cell anterior to R (figs. 13, 19), (short-winged individuals frequent, fig. 23); segment 3 of antenna of normal length, much shorter than head (world-wide) . . . . . **Psyllipsocus** Selys
2. A well-developed lacinia (maxillary pick) present; legs without scales (western North America) . . . . . **Speleketor,** new genus
   Lacinia absent; legs covered with scales (western Europe) . **Prionoglaris** Enderlein

Speleketor[2], new genus

Generic Description.—Eyes with many facets, posterior margins remote from occiput; three ocelli; antenna longer than body, without setae, segments from third to apex minutely annulated, segmentation poorly developed at apex, apparently more than 13 segments; segments of antenna immediately following second extremely elongate; clypeus well developed, tumid; mandibles asymmetrical, fitted for chewing; labium weakly sclerotized, palpi present; hypopharynx with well developed pharyngeal or postoral sclerite and ovoid ventral sclerites; maxilla with slender, toothed lacinia; maxillary palpus elongate.

Pronotum short, distinct from mesonotum; legs elongate, slender, without scales; apical spurs of tibiae 4–4–4; femora and tibiae with fine, setalike spines; tarsi with fine spines, no ctenidia; each claw with ventral seta near apex. Wings without setae, venation much as in *Prionoglaris* (figs. 14, 15); abdomen well developed, with differentiated genitalia; male genitalia largely concealed by subgenital plate; female with large, platelike gonapophyses.

Genotype.—*Speleketor flocki*, new species.

Speleketor flocki, new species

(Figs. 1–12, 15, 24–28)

Male.—General body form as in fig. 3; head in frontal view as in fig. 1; eyes prominent, posterior margins slightly anterior to level of posterior margins of lateral ocelli; clypeus much swollen, anterior margin broadly emarginate in ventro-frontal view. Antenna with segments 1 and 2 short, globose; segment 3 about as long as middle tibia; segments 4–6 each somewhat more than one-half as long as segment 3; following segments successively shorter and segmentation difficult to distinguish from annulations (fig. 9 of a portion of segment 5). Mandibles (figs. 11, 12, in dorsal view) heavily sclerotized, asymmetrically developed in molar region; apex of mandible compressed laterally, chisel-like, with a blunt, subapical tooth. Labium (fig. 2, in ventral view) with well developed median lobes bearing sclerotized apical areas sparsely clothed with minute, short setae; a poorly defined membranous sclerite dorsad of median lobes extending between them apically; palpus borne laterally, the apical segment directed anteriorly and with sclerotized apical area. Hypopharynx (fig. 5, in ventral view) with well developed postoral and ovoid sclerites (further described in later discussion of mouth parts). Galea of maxilla having several sclerotized regions as illustrated (fig. 4); lacinia (fig. 7) slightly irregular at truncate apex, a shoulderlike preapical tooth; cardo and stipes partly fused; basal segment of palpus subquadrate; segment 2 with irregular external margin bearing setae, remainder of segment more sparsely clothed with setae, a short spur near base; apical segment with numerous setae, a sensory area at apex.

Prothorax weakly sclerotized; meso- and metathoracic sclerites well indicated (fig. 3). Front femur somewhat more robust than middle

[2]From two Greek words meaning "cave" and "to inhabit."

and hind femora; front and middle femora subequal in length, hind femur slightly longer; front femur with 10–12 minute setalike spines along basal two-thirds of ventro-anterior margin and 1 or 2 well separated, long, delicate sensory setae on ventro-posterior margin; middle and hind femora naked except for sensory setae and sparse minute pile. Tibiae circular in cross section, ventral surfaces with numerous minute spines; middle tibia about three-fourths the length of hind tibia and slightly longer than front tibia. Tarsus with segment 3 unarmed; paired claws, each with curved ventral seta and irregular ventral margin just basad of seta attachment (fig. 8); arolium absent. Front tarsus with basal segment armed with about 7 ventral spines, one of them at apex; middle tarsus with segments slightly longer than corresponding segments of front tarsus and similarly armed; hind tarsus with segment 1 bearing 7–10 ventral spines and paired apical spurs; segment 2 with 2–3 ventral spines and paired apical spurs; each segment of hind tarsus noticeably larger than corresponding segment of middle tarsus.

Wings as illustrated (fig. 15), with some variation; one specimen has a crossvein between R_{4+5} and M_1 of one hind wing, making a closed apical cell, other hind wing normal; one specimen has M_3 of one front wing arising from base of M_2, other front wing normal.

Abdomen robust, fleshy, 8 well marked segments anterior to genital segments. Terminalia: Supraanal plate broadly triangular and poorly defined; each paraproct an irregular oblong plate, with a circular nonsclerotized area in the dorso-lateral region, and an elongate nonsclerotized area in the ventro-lateral region, each of the areas bearing several setae; subgenital plate and associated structures in ventral view as in fig. 28; apex of plate broadly rounded, but laterally compressed so that it appears pointed in ventral view. Genitalia (figs. 27, 28) lying dorsad of subgenital plate, the rounded yokelike base visible through the transparent subgenital plate, the appendages imbedded in muscle and with extreme apices of apical arms visible dorsad near paraprocts.

Coloration: Head brownish, light and dark areas as in fig. 1; eyes and area surrounding each ocellus black; antennal segments 1 and 2 pale, flagellum light brown. Prothorax dirty white; meso- and metathorax with dorsal lobes dark brown, pleural sclerites light brown; front coxa pale, middle and hind coxae darker; femora fuscous in apical fourth; tibiae and tarsi pale. Wing membrane colorless; veins dark brown, those at apex of front wing and in apical and posterior parts of hind wing paler. Abdomen white, segments 1–8 marked with reddish brown as in fig. 3, a mid-dorsal row of spots, 3 lateral rows on

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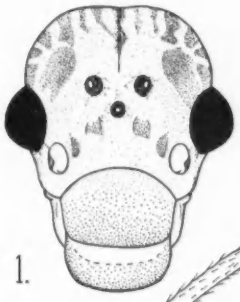
EXPLANATION OF PLATE I

Speleketor flocki, new species. Fig. 1. Female paratype, frontal view of head. 2. Female paratype, ventral view of labium. 3. Male paratype, general lateral view. 4. Female paratype, ventral view of right maxilla. 5. Female paratype, ventral view of hypopharynx.

(Figures 2, 5–7, 10, 16–18, 21, 22, 24–27, 29, 31, 32, 34, and 38 made with the aid of mercurochrome-stained, potash-treated, slide-mounted preparations; all drawings by the author.)



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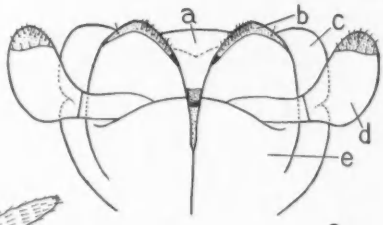

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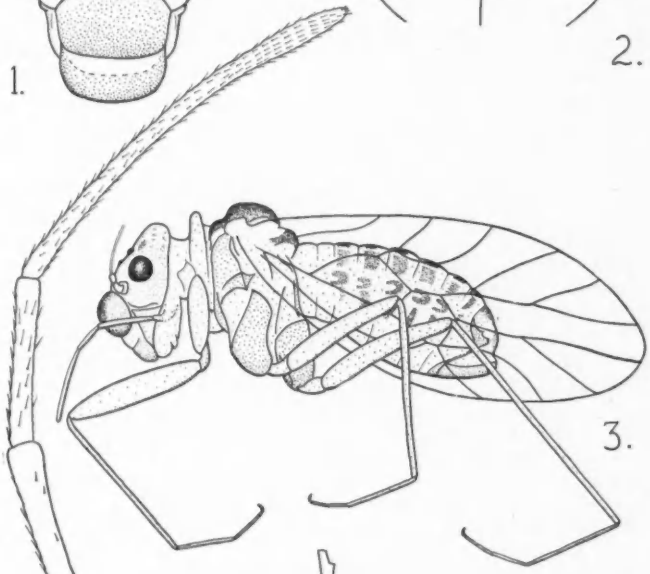

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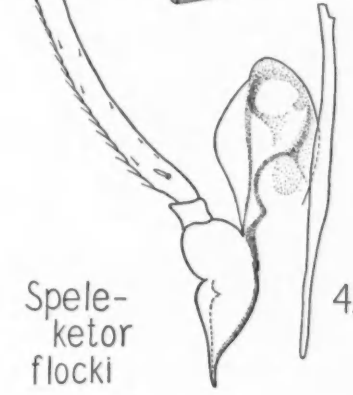

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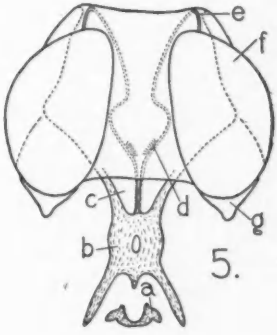


5.

each side; genital segments pale brown, more heavily sclerotized portions darker.

Measurements (of a representative specimen): Length of body 3.5 mm., of front wing 4 mm., of hind wing 2.4 mm., of hind tibia 1.9 mm.; width of head (including eyes) 0.9 mm.

Female.—Differing from male in terminalia: Apex of abdomen as in fig. 25 in ventral view; each gonapophysis convex, when pressed flat as in fig. 24; subgenital plate moderately sclerotized and rather poorly delimited, anterior margin with 2 short, blunt projections curving dorsad, posterior margin broadly emarginate.

Coloration and measurements as in male.

Nymphs.—Resembling adults in general body form; ranging from 2.7 mm. to 4.5 mm. in length. Front wing pads reaching about one-third the length of abdomen in stage preceding maturity, rudimentary in the smallest specimens. Hind tarsus of largest nymphs 3-segmented, front and middle tarsi 2-segmented with division of the apical segment poorly indicated; tarsi of small nymphs 2-segmented. Eyes of small nymphs much reduced in size, black and conspicuous. Antenna extremely elongate and setaceous, about 13 segments in larger specimens. Mandibles essentially as in adult; apex less elongate and chisel-like than that of adult; marginal flange of anterior third of molar region of right mandible not so fully developed as that of adult. Lacinia (fig. 6) strongly tridentate, shorter than in adult. Color pattern of head and abdomen similar to that of adult, particularly in larger nymphs.

Type locality.—Tucson Mountains, Ariz.

Type.—United States National Museum No. 55134.

Holotype.—Male collected March 2, 1941, by R. A. Flock.

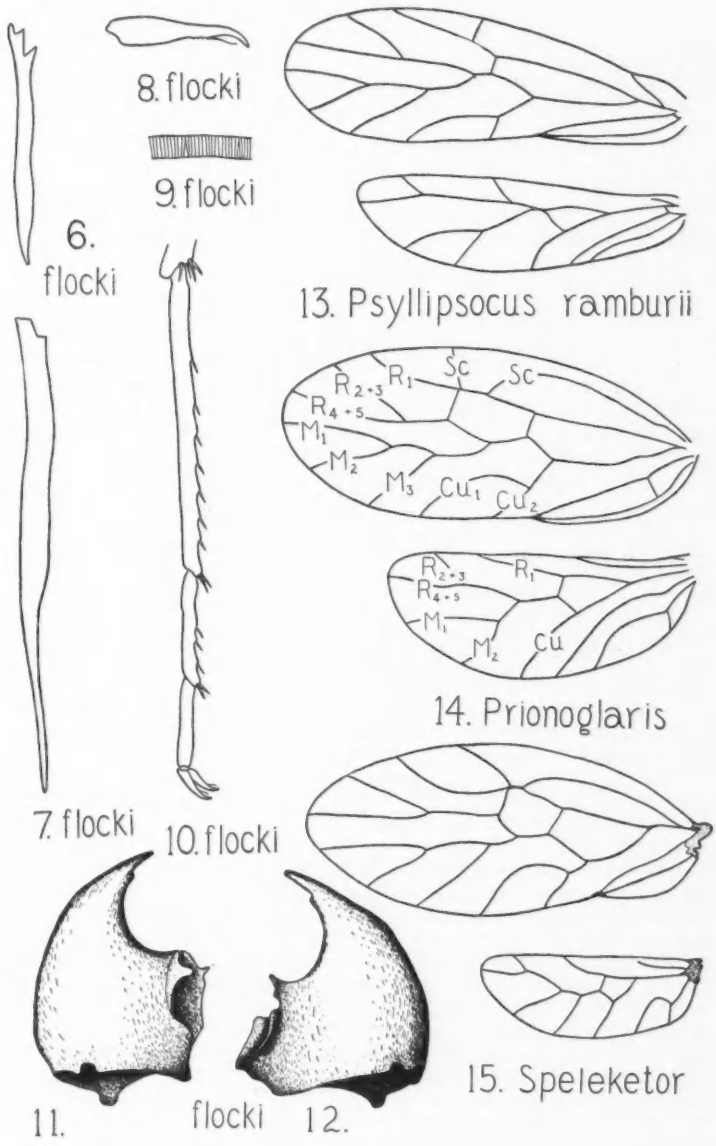
Allotype.—Female with same data as holotype.

Paratypes.—Forty-three males, 12 females, and 15 nymphs with same data as holotype; 1 male, 1 female, and 3 nymphs taken at type locality December 23, 1940. Of the above paratypes, collected March 2, 26 males, 2 females, and 7 nymphs are returned to Mr. Flock; 1 male and 1 female are deposited in the Museum of Comparative Zoology, Cambridge, Mass.; 1 male and 1 female in the collection of P. J. Chapman, Geneva, N. Y.; 2 males and 1 female and 1 nymph in the Illinois Natural History Survey, Urbana, Ill.; 1 male and 1 female in the Academy of Natural Sciences of Philadelphia. A few additional specimens from the type locality, not considered paratypes, have been dissected for slide mounts and other special preparations.

EXPLANATION OF PLATE II

Figs. 6–12. *Speleketor flocki*, new species. 6. Nymphal paratype, ventral view of right lacinia. 7. Female paratype, ventral view of right lacinia. 8. Male paratype, claw from hind tarsus. 9. Female paratype, small section of segment 5 of antenna. 10. Female paratype, lateral view of right hind tarsus and apex of tibia. 11. Male paratype, dorsal view of left mandible. 12. Same specimen as in fig. 11, dorsal view of right mandible.

Fig. 13. *Psyllipsocus ramburii* Selys, wings (after Enderlein, 1927, fig. 29). 14. *Prionoglaris stygia* Enderlein, wings (after Enderlein, 1919, fig. 21). 15. *Speleketor flocki*, new species, female paratype, wings.


8. flocki
9. flocki
6. flocki
13. Psyllipsocus ramburii
Sc
Sc
R1
R2+3
R4+5
M1
M2
M3
Cu1
Cu2
R2+3
R4+5
R1
M1
M2
Cu
14. Prionoglaris
7. flocki
10. flocki
15. Speleketor
11. flocki 12.

The Genus **Prionoglaris** Enderlein

Prionoglaris Enderlein, 1909, Arch. Zool. Expt. Gén., Sér. 5, T. 1, p. 533. Genotype, *Prionoglaris stygia* Enderlein, 1909 (monotypic).
Scoliopsyllopsis Enderlein, 1912, Zool. Anz., Bd. 39, p. 304. Genotype, (*Scoliopsyllopsis latreillei* Enderlein, 1912) = *Prionoglaris stygia* Enderlein, 1909 (monotypic).

Prionoglaris is closely related to *Speleketor*, differing as follows: Lacinia absent in adult; mandibles undergoing change from nymph to adult, with marked reduction of molar region; postoral sclerite of hypopharynx very differently shaped from that shown in fig. 5; legs covered with scales.

It is uncertain how much generic significance should be attached to the differences in wing venation (figs. 14, 15) and to several other features mentioned below, but certain of them, as the differences in the forking of vein M of the hind wing, are probably of more than specific value. The maxillary palpus of *Prionoglaris*, illustrated by Badonnel (1931), is much shorter than that of *Speleketor*. A well sclerotized aedeagus, unlike anything known in *Speleketor*, is figured by Ball (1936). As described and figured by Enderlein (1909), the nymph of *Prionoglaris* has a large, almost subquadrate pronotum, in dorsal view, in contrast to the very short pronotum of *Speleketor*. Although the much larger eyes of *Prionoglaris*, which extend to the posterior margin of the head in both nymph and adult, are noticeably different from those of *Speleketor*, generic significance is questionable because of the known variation found in *Psyllipsocus*. According to Ball (1936), the legs of nymphs in *Prionoglaris* are densely covered with microtrichiae; legs of adults are entirely covered by small plaques in the form of imbricated scales, each scale with four to six longitudinal grooves; there are no microtrichiae in the adults. Each tarsal claw has a strong preapical tooth in the nymph; the adult claw is untoothed, but shows preapical thickening.

Figs. 21 and 30 of Enderlein (1919), showing left and right wings of *stygia*, respectively, differ in the absence of a cross vein between the anal veins of the front wing as shown in fig. 30, though it occurs in fig. 21.

The wing venation and antennae ally *Prionoglaris* and *Speleketor* closely, but the differences mentioned above are so striking that to assign an Arizona species to a genus known only in western Europe would be unwise.

Prionoglaris stygia was described by Enderlein (1909) from 15 specimens (later shown to be nymphs) collected in a cave in the Pyrenees in 1907. The adult was later described (Enderlein, 1912) as *Scoliopsyllopsis latreillei* from a single female collected by Latreille, and labelled Paris, in the Selys Collection. The type of *latreillei* is illustrated in color by Enderlein (1919). The body length of the dried type is 4 mm., the length of the front wing 5.7 mm. As a result of rearing nymphs to maturity and examining the type of *stygia*, Ball (1936) showed the two genera to be based upon the same species. Badonnel (1931) had previously made *Scoliopsyllopsis* the basis of a new family, the Scoliopsyllopsidae. Though Karny (1930) placed *Scoliopsyllopsis* in the Psyllipsocini, he did not recognize *Prionoglaris* as the same and placed it in a special subfamily containing only the one genus.

In Belgium, LeRuth (1939) found specimens of *stygia* in all the caves reported; it was abundant and in one cave several hundred specimens were taken. The insect showed preference for inclined areas on the walls, there remaining motionless, but fleeing rapidly when disturbed. It was found in light zones of entrance galleries, as well as farther back in the caves.

The Genus **Psyllipsocus** Selys

Psyllipsocus Selys, 1872, Ent. Mo. Mag., vol. 9, pp. 145–146. Genotype, *Psyllipsocus ramburii* Selys, 1872 (monotypic).

Nymphopsocus Enderlein, 1903, Zool. Anz., Bd. 27, p. 76. Genotype, (*Nymphopsocus destructor* Enderlein, 1903) = *Psyllipsocus ramburii* Selys, 1872 (monotypic).

Parempheria Enderlein, 1906, Stett. Ent. Zeit., Jahrg. 67, H. 1, pp. 306–307. Genotype, (*Parempheria sauteri* Enderlein, 1906) = *Psyllipsocus sauteri* (Enderlein) (new combination) (new synonymy) (monotypic).

Ocelloria Weber, 1906, N. Y. Med. Jour., vol. 84, p. 885. Genotype, (*Ocelloria gravonymphia* Weber, 1906) = *Psyllipsocus ramburii* Selys, 1872 (new synonymy) (monotypic).

Ocellataria Weber, 1907, Ent. News, vol. 18, p. 189. Genotype, (*Ocellataria gravinympha* Weber, 1907) = *Psyllipsocus ramburii* Selys, 1872 (monotypic).

Fita Navas, 1913, Rev. Real Acad. Ci. Madrid, T. 12, p. 332. Genotype, (*Fita vestigator* Navas, 1913) = *Psyllipsocus ramburii* Selys, 1872 (monotypic).

Fabrella Lacroix, 1915, Bull. Soc. Ent. Fr., p. 194. Genotype, (*Fabrella convexa* Lacroix, 1915) = *Psyllipsocus ramburii* Selys, 1872 (monotypic).

Generic Description.—Much like *Speleketor*, except in the characters noted here. Eyes with posterior margins remote from or near occiput; 3 ocelli usually present, sometimes vestigial or absent in short-winged individuals; antenna with 22–30 segments, about as long as body, no segments extremely long; clypeus less tumid than in *Speleketor*; wings fully developed, with distinct venation, or much reduced, with rudimentary venation, never with closed cell anterior to vein R, a few fine setae sometimes present on veins (see figs. 13, 19, 35).

The apical spurs of the tibiae are apparently 4–4–4, but these characters of several species have not been described. A subapical tooth on each tarsal claw is present in all species except possibly *sauteri*. The tarsal claws of *sauteri* were originally described as lacking apical teeth and this was given as a generic character of *Parempheria*. *Parempheria minutissima*, a closely related species, was later described by Enderlein (1920), and, since Takahashi (1938) has reported a minute tooth near the apex of each claw, it is possible that the tooth occurs in *sauteri*. In *ramburii* and *yucatan* the tooth is so minute as to be overlooked unless examined very carefully. This tooth is different from the strong subapical setae of *Speleketor*. Pearman's statement (1924) that 13-segmented antennae occur in *ramburii* was probably due to an abnormal specimen or to an oversight, as the number is most often 26.

Variation in wing venation, and the presence, at least in *ramburii*, of both short-winged and long-winged individuals, have been largely responsible for the extensive generic synonymy. Reuter (1904) was the first to suggest, after finding specimens referable to both *Nymphopsocus destructor* and *Psyllipsocus ramburii* in the same colony, that only one species was present, and Tullgren (1909) concluded, after careful com-

parisons of both forms collected in houses in Stockholm, that *Nymphopsocus* was only a short-winged form. Pearman (1935) described his observations, made over a period of some months, of two colonies living in a building under undisturbed conditions; in each colony adults of both types appeared at intervals, though at times only the *Nymphopsocus* type occurred. He also found individuals, such as he illustrated (1924), with wings intermediate in length between typical short-winged and long-winged forms. Jentsch (1938, p. 32) has also noted specimens of intermediate wing length, and similar material from Massachusetts, New York, and Virginia is in the National Museum. In view of these observations, which have been generally accepted by Badonnel (1938) and other recent writers, there is no doubt regarding the synonymy of *Nymphopsocus*. Enderlein (1909) stated that anal spines (two strong spines, one of which is the larger, on each paraproct; see fig. 17) were absent in *Psyllipsocus*, though present in *Nymphopsocus*. Pearman (1935) has found spines in *Psyllipsocus*, but mentions that in one individual examined they were weakly developed. I have found a noticeable size difference in the spines of the left and right paraprocts of the same specimen (short-winged) from Massachusetts, so a considerable amount of normal variation is evident.

The variation of the wing venation of *ramburii* (genotype of *Psyllipsocus*) illustrated by Enderlein (1903c, pl. 11) and others shows that the venation of *sauteri* (genotype of *Parempheria*), illustrated by Enderlein (1906), does not warrant generic separation. The extent to which normal variation in psocid wing venation may occur is shown by Enderlein (1908b) in a study of *Psoquilla*. The margins of the wings of *sauteri* are said to have pubescence in the form of many rows of fine hairs, while the veins have a single row. Occasional setae occur on the wing veins of *ramburii*. Examination of *yucatan* with the higher power of a compound microscope (magnification of about 250 diameters) discloses minute, sparsely distributed setae and also regularly occurring groups of longitudinal, parallel lines on the wing margin. The occasional setae could easily give the erroneous impression that the lines are setae, some of which extend perpendicular to the wing margin. Minute spicules occur on the wing veins. The pubescence described by Enderlein as a generic character of *Parempheria* is probably of such a nature, or a closely similar one, and probably is sufficiently widespread in this whole group of species as to be of little generic value. Although the claws of *Parempheria* are described as untoothed, minute teeth are said by Takahashi (1938) to occur in *Parempheria minutissima*, so the reported absence of a tooth in *sauteri* is questionable.

Ocelloria was probably proposed inadvertently,[3] since it was done simply by the use of the name in connection with an illustration and was not mentioned in the text of the paper. The same habitus illustration was used by Weber the following year when describing *Ocellataria* in a formal way. The types of *Ocellataria gravinympha* are short-

[3]It is unfortunate that new names were proposed by Weber (1906), as they have not been catalogued or included in nomenclators. In addition to the name *Ocelloria gravonymphia*, a new specific name in the genus *Clothilla* (which is a synonym of *Trogium;* see Gurney, 1939) was introduced by associating the name *Clothilla ocelloria* with an illustration of what is clearly *Trogium pulsatorium* (L.).

winged specimens of ***ramburii***. Pearman (1928, p. 212) placed *Ocellataria* as a synonym of *Nymphopsocus*, which in turn is a synonym of *Psyllipsocus*. Chapman and Nadler (1928) treated *Ocellataria* as a synonym of *Nymphopsocus*, and used the combination *Nymphopsocus gravinympha* Web. That *Fita* and *Fabrella* were each based on long-winged specimens of *ramburii* is suggested by illustrations accompanying the original descriptions; the synonymy was indicated by Badonnel (1935).

Of the Old World species referable to *Psyllipsocus*, only *ramburii* (which also occurs in the New World) is sufficiently well known to permit its inclusion in a practical key, and the key that follows is limited to the described American species. Jentsch (1939, p. 116) has recently mentioned two females of a species of *Parempheria* found in 1928 in packing material about orchids that were believed to be from Venezuela. Very likely this species and others yet to be discovered in tropical America are members of *Psyllipsocus* as here treated. In the absence of a complete key, it is hoped that the following notes on Old World species will be helpful.

Enderlein (1909) described *Nymphopsocus troglodyta* from caves in France and Spain, and a variety, *algericus*, from Algeria. They are short-winged and said to be very closely related to *destructor* (synonym of *ramburii*), differing in the absence of ocelli and in the minute, cross-hatched structure of the abdominal body wall. The variety *algericus* was described as possessing spots of reddish pigment in the place of ocelli, the ocellar area of typical *troglodyta* being uncolored. Badonnel (1935) treated the latter as *Psyllipsocus* (*Nymphopsocus*) *troglodytes*, suggested that it might be a form of *ramburii*, but provisionally treated it as distinct. Jeannel (1926), Wolf (1934), and LeRuth (1939) treated *troglodytes*, and Wolf listed *algericus* as a distinct species.

Three species of *Parempheria*—*sauteri* (Japan), *metamicroptera* (Formosa), and *minutissima* (Hawaii)—were described by Enderlein in 1906, 1908a, and 1920, respectively. Reasons for considering *Parempheria* a synonym of *Psyllipsocus* have already been given. As described, *sauteri* differs from both *oculatus* and long-winged specimens of *ramburii* in having a more elongate and flattened cell Cu_1 (cell formed by Cu_1 and Cu_2 with the posterior margin of wing, often called the areola postica) of the front wing. It is a larger species than *yucatan* and the apical discal cell of the front wing is differently shaped in the two species. The hind wing of *metamicroptera* was figured by Enderlein (1908a); it has no closed cell, which may be owing to a considerable reduction in length. The front wing is apparently much like that of *sauteri*. Whether the described condition of the hind wing is normal is unknown, but Enderlein had seven specimens, and apparently the reduction in size and venation was constant. The species should be known as *Psyllipsocus metamicropterus* (End.) (new combination). *Parempheria minutissima* is reported by Takahashi (1938) to be rather common in dwellings in Formosa, and he has enlarged upon the original description. The wing venation is very much like that of *sauteri*, but *sauteri* is larger than *minutissima*. The correct name becomes *Psyllipsocus minutissimus* (End.) (new combination).

Cockerell (1916) described the fossil *Psyllipsocus banksi* from Burmese amber.

A specimen of *Psyllipsocus* belonging to the Museum of Comparative Zoology has been examined that bears the following data: "Piti, Guam, Nov. 2, 1936, in food cupboard, O. H. Swezey, collector." Additional material is needed for adequate study, but several characters suggest relationship to *P. yucatan*.

KEY TO THE AMERICAN SPECIES OF PSYLLIPSOCUS

1. Apical segment of maxillary palpus tapering at apex, broadly rounded on inner margin (fig. 22), (both short-winged and long-winged individuals; males unknown), (Europe and North America).....**ramburii** Selys
   Apical segment of maxillary palpus broad, apex more or less oblique (figs. 34, 36), (only long-winged individuals known), (southern part of North America).....2
2. Eyes especially prominent (fig. 40); apical segment of maxillary palpus with apex weakly oblique (fig. 36); male subgenital plate without conspicuous heavily sclerotized lateral margins, an elongate median structure on dorsal surface (figs. 38, 39); larger species.....**oculatus,** new species
   Eyes moderately prominent (fig. 37); apical segment of maxillary palpus with apex strongly oblique (fig. 34); male subgenital plate with conspicuous, heavily sclerotized lateral margins, a circular median structure on dorsal surface near apex (figs. 29, 30); smaller species.....**yucatan,** new species

Psyllipsocus ramburii Selys[4]

(Figs. 13, 16, 17, 20, 22, 23, 32)

Psyllipsocus ramburii Selys, 1872, Ent. Mo. Mag., vol. 9, pp. 145–146.
Nymphopsocus destructor Enderlein, 1903, Zool. Anz., Bd. 27, p. 76.
Ocelloria gravonymphia Weber, 1906, N. Y. Med. Jour., vol. 84, p. 885, (new synonymy).
Ocellataria gravinympha Weber, 1907, Ent. News, vol. 18, pp. 189–194, (new synonymy).
Fita vestigator Navas, 1913, Rev. Real Acad. Ci. Madrid, T. 12, p. 333.
Fabrella convexa Lacroix, 1915, Bull. Soc. Ent. Fr., p. 194.

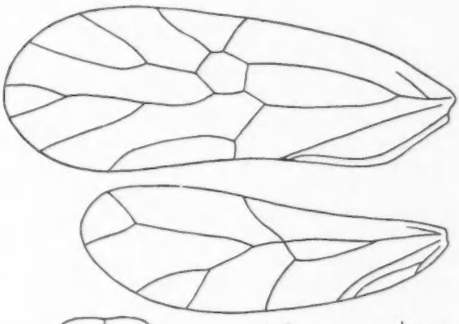
Short-winged Female (males of *ramburii* unknown).—General appearance as in fig. 23. Head with posterior margin much wider than prothorax; frontal view as in fig. 20; ocelli reduced, distinct. Maxillary palpus (fig. 22) with apical segment elongate, very differently shaped from corresponding segment in *yucatan* or *oculatus*

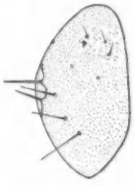
[4]The specific name of this species of often spelled with one *i*, but Selys (1872) used the double *i* and this orthography should be followed, as has been done by Pearman (1935). Opinion 8 of the International Commission on Zoological Nomenclature states that in such cases the original spelling is to be retained.

EXPLANATION OF PLATE III

Fig. 16. *Psyllipsocus ramburii* Selys, short-winged female, wings. Port Washington, N. Y., September 20, 1937. 17. Same, short-winged female, right paraproct. Cummington, Mass., June 1, 1941. 18. *P. yucatan*, new species, female paratype, right paraproct. 19. Same, male paratype, wings. 20. *P. ramburii* Selys, short-winged female, frontal view of head. Cummington, Mass., June 1, 1941. 21. *P. yucatan*, new species, female paratype, supraanal plate. 22. *P. ramburii* Selys, short-winged female, ventral view of right maxilla. Cummington, Mass., June 1, 1941. 23. Same, general dorsal view of short-winged female. Cummington, Mass., June 1, 1941. (Femora foreshortened.)

16. ramburii



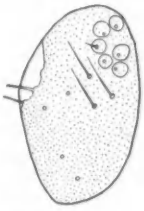


17. ramburii

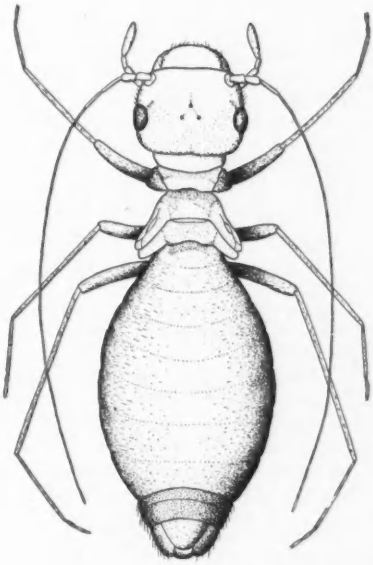
19. yucatan

20. ramburii

21. yucatan



18. yucatan



22. ramburii

23. ramburii

(figs. 34, 36); galea broad, marked by sclerotizations as illustrated; lacinia apically tridentate. Hypopharynx differing from that of *Speleketor* in the more nearly square shape of postoral sclerite and larger hypopharyngeal brush. Apical segment of labial palpus considerably broader than median lobe, in contrast to proportions in *Speleketor* (fig. 2). Mandibles of same type as those of *Speleketor;* subapical tooth of each mandible more prominent than that of corresponding mandible of *Speleketor;* notch of dorsal margin of molar region of right mandible occupying more of molar face than that of *Speleketor* and differently shaped; tooth of dorsal margin of molar region of left mandible more broadly rounded and less elongate than that of *Speleketor*. Antenna with about 26 segments. A distinct, poorly sclerotized neck region (largely concealed when head is retracted). Wings of variable length, usually as in fig. 16; veins broad and rudimentary; small but well developed setae occasional on veins and margins of front wing, rare on hind wing. Femora slender (somewhat foreshortened in fig. 23). Proportions of femur, tibia, and first, second, and third tarsal segments of front leg of a representative specimen as 3 : 4 : 1.6 : 0.5 : 0.6; of hind leg, 4 : 6.7 : 2.8 : 0.5 : 0.6.

Segmentation of abdomen not clearly visible, setae minute and scarcely noticeable with binocular microscope (magnification of about 70 diameters or less) except near apex, numerous minute setae visible with compound microscope. Genitalia much like those of *yucatan*, differing in details as illustrated. Paraproct with sparsely distributed strong setae; sensory area near base of paraproct (end toward supraanal plate) less noticeably developed than in *yucatan*, with numerous small setae; two spines of variable size borne on a ridge near margin of inner side, the basal one the larger, often much more conspicuously so than in fig. 17, in such cases easily seen with binocular microscope. Gonapophysis (fig. 32) with heavily sclerotized supporting structure extending about one-half distance from base to apex, lateral areas less sclerotized than apical region; egg guide closely associated near inner margin.

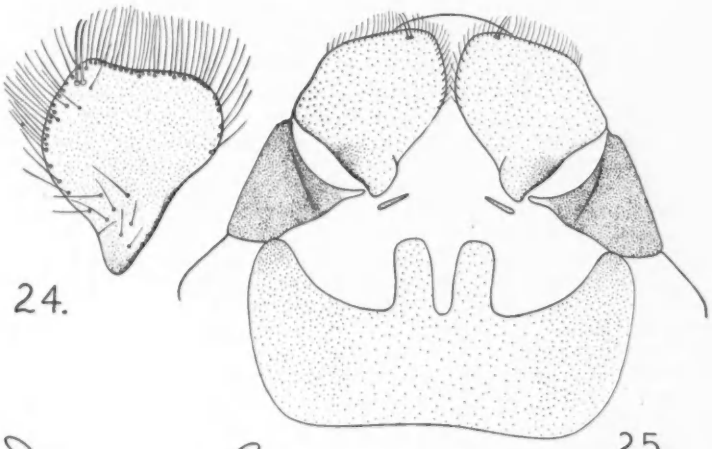
Coloration: General color dirty gray. Eyes brown; ocelli and a short oblique line extending anteriorly and mesally from each eye reddish; antenna whitish; dorsal region of thorax, a small area at base of first tergum, apex of abdomen, and legs darker gray, as illustrated (fig. 23).

Measurements (of representative specimen): Length of body 2 mm., of head in direct frontal view 0.55 mm., of hind tibia 0.75 mm.

Long-winged Female.—Differing from short-winged form in more swollen thoracic region and in larger ocelli and eyes, the latter somewhat remote from posterior margin of head. Wing venation most often as in fig. 13, but variable (see Enderlein, 1903c, pl. 11), especially

EXPLANATION OF PLATE IV

Speleketor flocki, new species. Fig. 24. Female paratype, right gonapophysis. 25. Female paratype, ventral view of apex of abdomen. 26. Female paratype, right paraproct. 27. Male paratype, genitalia. 28. Male paratype, ventral view of apex of abdomen.



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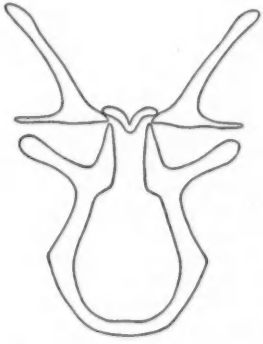
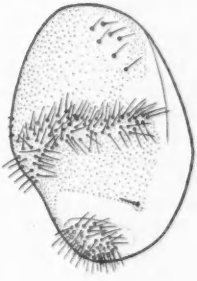
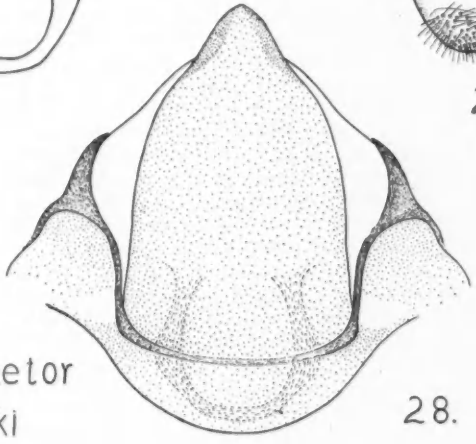


27.



26.



Speleketor
flocki

28.

as regards the position of vein M and the presence or absence of a crossvein forming a second discal cell of front wing similar to that in *yucatan* and *oculatus* (figs. 19, 35) (when present, cell practically rectangular, more like that of *oculatus* than that of *yucatan*); vein R_{4+5} of front wing briefly forked at apex in one specimen examined; vein M of hind wing variable in two Virginia adults, in one wing of each unforked. Massachusetts specimens show considerable variation; R_{2+3} and R_{4+5} of front wing are sometimes fused or connected by a crossvein; one specimen has no closed cell in the hind wing; another has R_s+M of hind wing abnormal, a second closed cell being formed.

Coloration: About as in short-winged form; wings immaculate.

Measurements: No apparent differences between short-winged and long-winged specimens examined; length of front wing of representative specimen from New York 2 mm., greatest width of front wing 0.7 mm.

Nymphs.—Immature specimens varying from slightly less than 1 mm. to 2 mm. in body length have been studied. Ocelli absent and eyes minute; apex of lacinia tridentate. Wings absent in smaller specimens, present as pads in larger ones. Tarsi two-segmented. Entire body whitish except for reddish eyes and apices of mandibles and laciniae. Certain nymphs were described by Weber (1907) as bright yellow.

Jentsch (1940) found that nerves going to the ocelli of short-winged specimens are reduced in size, compared with those of long-winged specimens. The number and length of the ommatidia in short-winged specimens are also less. These structures were illustrated by Jentsch.

Biological Notes.—Although recorded by Jentsch (1938) and several earlier writers from various locations within houses, such as on walls, beneath carpets, in staircases and almost any available cracks, ***ramburii*** shows preference for humid conditions, as evidenced by its discovery in caves by LeRuth (1939) and Badonnel (1938). Weber (1907) reared the species for three seasons in a cellar, and found it on wine jugs and barrels, a situation comparable to the vinegar barrels from which my Massachusetts collection was made. Badonnel (1938) found the presence of moisture necessary when rearing ***ramburii*** in cardboard boxes. His specimens were strongly attracted to a drop of water, but, after approaching a drop to the point of touch, they were repelled, and death resulted if they became engulfed in the water. Badonnel's captive specimens ate flour eagerly, and attempted to eat starch, sugar, paper, and cotton, but these materials did not appear satisfactory, and best rearing results were obtained in cages where the green mold, *Penicillium*, was abundant. Some cannibalism was noted, unhatched eggs and dead nymphs being eaten. Badonnel concluded that ***ramburii*** is polyphagous, but that molds constitute a normal item of diet.

The eggs, described by Pearman (1928), are laid individually and are not covered by a web or crusty coating as is the case with many Corrodentia. Each egg is "ellipsoidal, sculptured with tiny, alternately ranked, papillaceous processes," white, and very delicate. One female observed by Badonnel laid 21 eggs in 20 days, on some days laying as

many as five eggs, on others none. Weber (1907) reported that eggs, glued fast in cracks and other favorable places, hatch in 8–10 days, according to conditions. At 20–21° C. eggs under observation by Badonnel hatched in 18–19 days, at 25–26° C. in 14–15 days. Weber was apparently confused in his interpretation of the various members of a colony, as he recognized three nymphal stages and males as well as females. Although the types of *gravinympha* were said to include two males and a female, only females are present on the type slide in the National Museum, and no males of the species are known. Badonnel's short-winged specimens passed through five nymphal stages; fully winged individuals or those with wings of intermediate length had six. Factors responsible for the full development of wings are not known, though the possibility of fluctuations in temperature being involved is suggested by Badonnel. One individual, reared from a third-instar nymph, matured with front wings typical of the short-winged form and hind wings reaching half the length of the abdomen. Observations in England by Pearman (1935) indicate that long-winged forms may be most numerous in the latter part of the summer, and my collecting suggests that this is also true in Massachusetts. Pearman (1928) says that two generations are produced annually and the winter is passed in the nymphal condition. One might suspect, however, that the uniform conditions of certain caves or cellars would occasion little interruption of continuous breeding activity.

With the exception of Weber's redescription of the species from Pennsylvania, which was cited in Banks' catalogue of 1907, *ramburii* was not recorded from America until listed, both as *Psyllipsocus* and *Nymphopsocus*, from several localities in Brooklyn and New York City by Chapman and Nadler (1928). Nathan Banks writes (in litt.) that two specimens from Albany, N. Y., are in the Museum of Comparative Zoology.

The species is not known to be destructive, though said by Laing (1924) to be swarming among books and papers in a basement in London, England. Both Laing (1932) and Reuter (1909) feel that *ramburii* lends itself to ready transportation in commerce, and it may eventually be found widely distributed in the United States, occasionally appearing in such numbers as to be a nuisance.

Material examined (all females).—Cummington, Mass., on vinegar barrels in cellar of house, June 1, 1941, A. B. Gurney, 7 adults and 26 nymphs of short-winged form; same locality, July 20, 1941, 6 long-winged adults, 1 adult of intermediate wing length, 32 short-winged adults, and 10 nymphs of short-winged form; Port Washington, N. Y., September 20, 1937, L. D. Luey, 8 adults and 3 nymphs of short-winged form; Brooklyn, N. Y., in cellar, July 25, 1926, A. M. Nadler, 2 long-winged adults, 2 short-winged adults, and 11 nymphs, mostly of long-winged form (P. J. Chapman Collection); New York, N. Y., in cellar, May 17, 1925, A. M. Nadler, 1 long-winged adult (P. J. Chapman Collection); Woodside, N. Y., in apartment, M. Pollock, May 29, 1936, 1 adult of intermediate wing length and 1 nymph; Lancaster, Pa., July, 1904, slide bearing cotypes of *Ocellataria gravinympha* Weber, 3 short-winged adults (second specimen from label here selected as lectotype), United States National Museum Type No. 52355 (through

confusion with an accession number, incorrectly given in Weber's description as 46,844); Falls Church, Va., July 5, 1941, abundant in a dry, well-lighted basement of a house, A. R. Evers, 2 long-winged adults, 2 adults of intermediate wing length, 12 short-winged adults, and 12 nymphs of short-winged form. Except as otherwise noted, all the above material is in the United States National Museum.

Psyllipsocus yucatan, new species

(Figs. 18, 19, 21, 29–31, 33, 34, 37)

Psyllipsocus (near *ramburii* Selys), 1938, Pearse, Carnegie Inst. Wash., Pub. 491, p. 238.

Pearse recorded the present material from Chichen Itza, Yucatan, following my tentative identification.

Male.—Head (fig. 37) with eyes reaching posterior margin of head, not prominent laterally; frontal suture conspicuous posterior to ocelli; lateral sutures not noticeable; maxilla (fig. 34) with apical segment of palpus enlarged apically, the terminal margin strongly oblique, thus differing markedly from *ramburii* (fig. 22). Wings extending well beyond apex of abdomen, venation (fig. 19) scarcely varying in material examined, in one specimen vein R_1 of hind wing arising from R_s+M distad of discal cell. Abdomen weakly sclerotized except at apex; supraanal plate broadly triangular (fig. 21), sparsely covered with setae; paraproct (fig. 18) irregularly oval in outline, sensory area and anal spines near inner margin as illustrated. Apex of abdomen as in fig. 30 in ventral view; subgenital plate longitudinally divided at base, lateral areas conspicuously delimited by strongly sclerotized marginal supports, tapering to a moderately sclerotized blunt apex; slender paired arms of genitalia visible through base of subgenital plate and projecting anteriorly in body; dorsal view of subgenital plate as in fig. 29 when dissected, genitalic arms arising from irregular, roughly circular, well sclerotized structure.

Coloration: Body pale straw-colored; eyes brown; ocelli reddish; heavily sclerotized portions of mouth parts and genital segments dark brown; wing membrane faintly tinged with fuscous, a clear spot at posterior margin of wing between apex of Cu_2 and apices of anal veins; wing veins pale.

Measurements (of representative specimen): Length of body 1.15 mm., of hind tibia 0.5 mm., of front wing 1.25 mm.; greatest width of front wing 0.42 mm.

Female.—Essentially like male except for genitalia and somewhat greater size. Apex of abdomen as in fig. 33 in ventral view; each

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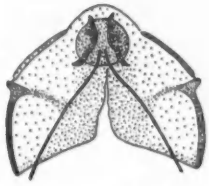
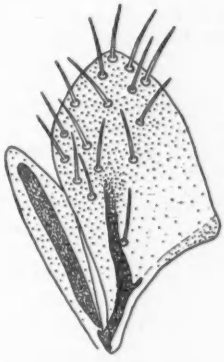
EXPLANATION OF PLATE V

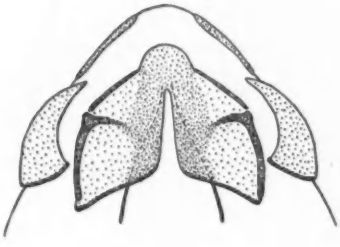
Fig. 29. *P. yucatan*, new species, male paratype, inner view of subgenital plate and genitalia. 30. Same, male paratype, ventral view of apex of abdomen. 31. Female paratype, right gonapophysis and egg guide (drawn to nearly twice the scale of fig. 32). 32. *P. ramburii* Selys, short-winged female, right gonapophysis and egg guide. Port Washington, N. Y., September 20, 1937. 33. *P. yucatan*, new species, female paratype, ventral view of apex of abdomen. 34. Same, female paratype, ventral view of right maxilla.



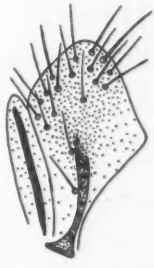
29. yucatan



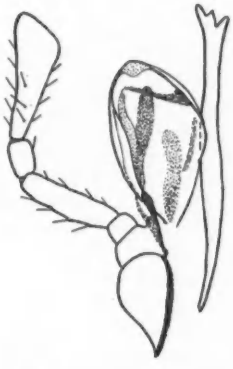
31. yucatan



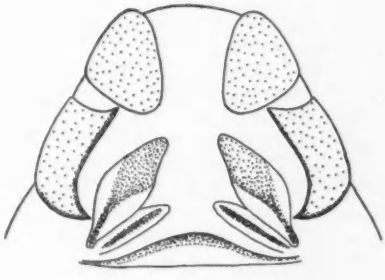
30. yucatan



32. ramburii



34. yucatan



33. yucatan

gonapophysis with more heavily sclerotized portions conspicuous, less sclerotized parts not clearly visible, in special preparation (fig. 31) very similar to that of *ramburii;* subgenital plate broadly rounded at apex, noticeably sclerotized only at apex; supraanal plate and paraproct as in male.

Coloration: As in male.

Measurements (of representative specimen): Length of body 1.3 mm., of hind tibia 0.5 mm., of front wing 1.3 mm.; greatest width of front wing 0.45 mm.

Nymph.—There are three nymphs, ranging from 0.8 mm. to 1.1 mm. in body length. They closely resemble adults in structure and color; wing pads of the larger nymphs extend one-half the distance to the apex of the abdomen.

Type locality.—Xtoloc Cenote Cave, Chichen Itza, Yucatan.

Type.—United States National Museum No. 55651.

Holotype.—Male collected in bat feces, June 24, 1936, by A. S. Pearse.

Allotype.—Female with same data as the holotype.

Paratypes.—One female and 3 males mounted on slides, and 2 males, 2 females, and 3 nymphs preserved in alcohol, all with same data as holotype. Several special dissections are on slides. One of the above slide-mounted males is deposited at the Museum of Comparative Zoology, Cambridge, Mass.

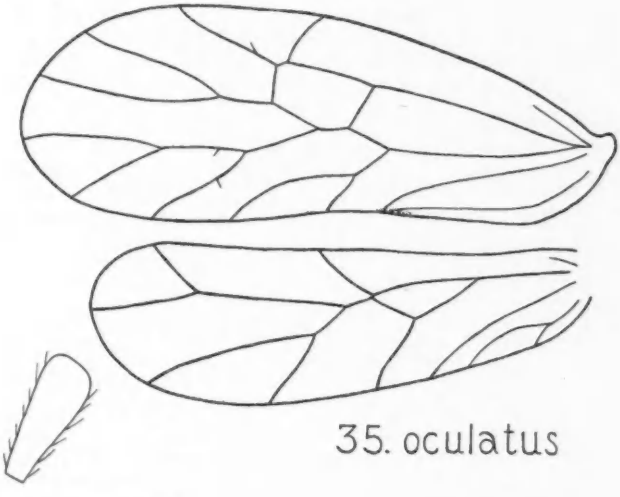
Psyllipsocus oculatus, new species

(Figs. 35, 36, 38–40)

Male.—Head (fig. 40) with prominent eyes; lateral arms of frontal suture visible; lacinia, galea, and length proportions of palpal segments of maxilla similar to those of *yucatan;* apical segment of palpus (fig. 36) with apex blunt, broadly rounded, the apical margin weakly oblique. Apical third of wings projecting beyond apex of abdomen; venation as in fig. 35, an occasional small seta on veins. Apex of abdomen in ventral view with sclerotized portions of apical terga and subgenital plate as illustrated (fig. 39); margins of subgenital plate weakly sclerotized and incurved so as to be unnoticeable until dissected and stained, main portion of disk moderately sclerotized and with no such thickened supporting margins as characterize *yucatan,* base undivided, apex weakly sclerotized; dorsal view of subgenital plate as in fig. 38 when dissected and flattened, weakly sclerotized marginal areas visible, a longitudinal, broadly lanceolate, heavily sclerotized median structure as illustrated, from near the base of which slender, well sclerotized genitalic arms arise.

EXPLANATION OF PLATE VI

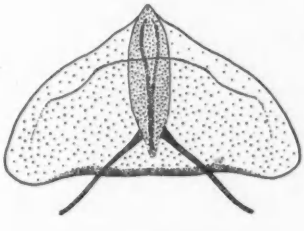
Fig. 35. *Psyllipsocus oculatus,* new species, male holotype, left wings. 36. Same, male holotype, ventral view of apical segment of right maxillary palpus. 37. *P. yucatan,* new species, male paratype, frontal view of head. 38. *P. oculatus,* new species, male holotype, inner view of subgenital plate and genitalia. 39. Same, male holotype, ventral view of apex of abdomen. 40. Same, male holotype, frontal view of head.



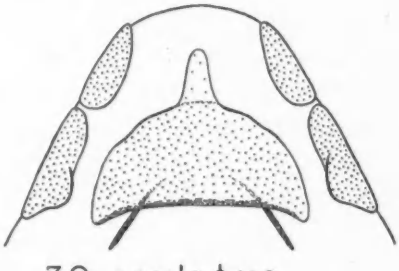
35. oculatus

36. oculatus

37. yucatan



38. oculatus



39. oculatus

40. oculatus

Color: Head a darker shade of straw color than in *yucatan;* eyes brown, margins black; ocelli pale; remainder of body and legs about as in *yucatan*; wing membrane barely tinged with fuscous, immaculate.

Measurements: Length of body 1.5 mm., of hind tibia 0.6 mm., of front wing 1.5 mm.; greatest width of front wing 0.6 mm.

Type locality.—Mexico.

Type.—United States National Museum No. 55652.

Holotype.—Male collected by C. P. Trotter, of the Bureau of Entomology and Plant Quarantine, on the international bridge, Laredo, Tex., June 7, 1940, with geranium plants in soil, found in baggage from unknown locality in Mexico.

Only the type is known, and description from an uncertain locality would be unwise, were the species not being treated in a comprehensive study which shows that *oculatus* clearly belongs to the same stock as *yucatan*.

NOTES ON MOUTHPARTS, WITH SPECIAL REFERENCE TO SPELEKETOR AND PRIONOGLARIS

An elongate, rodlike, often forked lacinia is usually considered a distinctive structure of Corrodentia, developed in no other insects except certain genera of Mallophaga. Because it is separated from the main body of the maxilla, unlike the lacinia of typical chewing insects, the lacinia of psocids was poorly understood by most early authors and its homologies uncertain (see Snodgrass, 1905). Muscles, nerves and other kinds of evidence recently have demonstrated that the "maxillary fork" is actually a modified and detached lacinia, as has been pointed out by Badonnel (1934, pp. 73–84). This view had been adopted earlier by Enderlein, but the proofs had not been fully demonstrated. Little information is available on the function of psocid laciniae. Pearman (1928, p. 268) was unable to verify the suggestions that had appeared concerning their use, and thinks that they may serve as supporting props or levers during the act of biting with the mandibles. Figs. 6 and 7 show the nymphal and adult laciniae of *Speleketor*.

An unusual feature of *Prionoglaris* is that the lacinia is lacking in the adult except for a membranous remnant. Badonnel (1931) first noticed this peculiarity, but had only one adult for study, whereas Ball (1936) had a series of nymphs and adults which enabled him to be certain of the absence of the lacinia in the adult and to compare nymphal and adult structures carefully. Although lacking in the adult, the lacinia is well developed in the nymph, at the apex sclerotized and quadridentate.

Ball (1936) has also described and illustrated the mandibles of *Prionoglaris*. Those of the nymph are of a typical chewing type, quadridentate in the incisor region, with the molar region well developed and transversely grooved. In contrast, the adult mandibles are extremely curved, long and tapering in the incisor region, the internal margin being finely denticulated; the molar region is simpler than that of the nymph. No changes of such an extent in mandibular shape occur in *Speleketor*.

Weber (1936), Cope (1940), and others have illustrated the labium of several psocids, and Badonnel (1931) has figured that of *Prionoglaris*, but the differences in structure found in various genera, coupled with differing interpretations, have not permitted the homologizing of all the labial structures of *Speleketor*. In ventral view (fig. 2) the labial palpi (*d*) are seen to originate at the apical margin of a ventrally convex prementum (*e*). The submentum is basad of the prementum. Each median lobe (*b*) is well developed and much more heavily sclerotized than a lateral expansion (*c*) of the same plate that is easily overlooked in all except stained preparations. Between the median lobes and dorsad of them is a weakly sclerotized lobe (*a*) which bears a posteriorly directed dorsal flap. The definite recognition of glossae and paraglossae has not been made in *Speleketor*.

Badonnel (1931) has illustrated the hypopharynx of *Prionoglaris*, and, since it is considerably different from that of *Speleketor*, it is important to describe this organ of the latter genus rather fully in order to emphasize the value of the hypopharynx in classification. Fig. 5 is a ventral view of the hypopharynx of *Speleketor* after treatment with caustic potash and stain, but the same structures are visible in an alcoholic specimen. Posteriorly, there is a well sclerotized postoral sclerite (*b*) which has diverging posterior arms for attachment and similar anterior extensions that serve to strengthen each side of the main anterior portion or lingua (*c*) of the hypopharynx. The postoral sclerite is convex on its ventral surface and there is a small hole as illustrated. Dorsally it is concave. In special preparations a small sclerite (*a*) appears attached by membranous connections to the postoral sclerite, but before dissection the small sclerite is located on the roof of the mouth in the epipharyngeal region of the clypeus and directly dorsad of the postoral sclerite. A small conical development of the epipharynx, associated with the small sclerite mentioned, is not sufficiently sclerotized to show well in a caustic potash preparation. The lingua (*c*) is weakly sclerotized and has a pair of chitinous filaments running its entire length. The filaments are strongly undulate as illustrated, and along the inner margin of each, near the base of the undulation, there is a group of setae (*d*) known as the hypopharyngeal brush. Ventrad of the lingua is a pair of large ovoid sclerites (*f*) borne on the weakly sclerotized extension of the lingua which curves ventrally and then posteriorly. The chitinous filaments (*e*) may be traced, just below the surface of the lingua, as they follow the curve from the dorsal surface of the lingua to the ventral surface of the hypopharynx where the ovoid sclerites occur. Each filament goes to the respective ovoid sclerite, and, in lateral view, it may be seen to extend along the lateral margin of the sclerite. Each ovoid sclerite is strongly convex ventrally and bears a small sclerite (*g*) at its posterior apex which serves as a point of attachment.

Badonnel (1931) states that the chitinous filaments of *Prionoglaris* are strong and rigid, differing from the long and supple ones of typical psocids (and of *Speleketor*). His figure of the postoral sclerite shows the shape of that structure to be very different from that of *Speleketor*, and the lingual region of the hypopharynx is also different.

The function of the parts of the psocid hypopharynx has been poorly understood for many years, but is now better known, owing to the researches of Badonnel, H. Weber, and others. Earlier authors, such as Snodgrass (1905), believed the chitinous filaments to be ducts and the ovoid sclerites lingual glands. Cope (1940) has recently adopted a modification of this view, maintaining that the ovoid sclerites are reservoirs connected by ducts to the postoral sclerite, which he regards as derived from a salivarium. While this view may be correct, Cope has not satisfactorily shown that the ovoid sclerites are not simply specialized thickened parts of the ventral region of the hypopharynx, as Badonnel (1934) believes. In a later paper, Badonnel (1936) discusses the ovoid sclerites and their connections in detail. Weber (1933, pp. 58–59; 1936, and other papers) described the postoral sclerite as a cup with its concave dorsal surface fitted to receive a plunger situated dorsad of its opening and operated by the huge muscles of the clypeus. His figures show that the structures function as a mortar and pestle. Food particles are considered to pass along the dorsal surface of the hypopharynx, between the molar regions of the apposable mandibles, to the cup, where further mastication occurs. From the cup the food goes to the pharynx and thence to the oesophagus. If this opinion be correct, the previously mentioned conical structure on the epipharynx of *Speleketor*, situated dorsad of the postoral sclerite, probably acts as a plunger or pestle for grinding food particles in the cup.

SUMMARY

The tribe Psyllipsocini includes *Psyllipsocus* Selys, *Prionoglaris* Enderlein, and *Speleketor*, new genus. The two latter genera are distinctive because of the wing venation and the very long segments in the antennal flagellum. *Prionoglaris* contains one species occurring in European caves, while a single new species of *Speleketor* lives in Arizona caves. The absence of a lacinia in adults of *Prionoglaris*, in addition to other peculiarities, makes the genus of unusual interest, and special attention is given to the mouth parts of *Prionoglaris* and *Speleketor*. *Scoliopsyllopsis* Enderlein is a synonym of *Prionoglaris*.

Psyllipsocus is best known on account of its genotype, *ramburii* Selys, which is dimorphic and often found in houses in Europe and America. *Parempheria* Enderlein is synonymized with *Psyllipsocus*. Attention is called to a paper by Weber (1906), overlooked by most writers, in which one new generic and two new specific names were proposed, apparently unintentionally. Three species of *Psyllipsocus* are recorded from America, two being described as new, and a key for their separation is given. Four additional species and one variety have been described from the Old World, and notes on each of them are given.

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The above three items received recently explain themselves by title. They appear to be taxonomy of a revisional nature, a type of study very much needed in American insects. American bees particularly need work other than the description of more new species. The untimely death of Miss Sandhouse was a severe blow to the present progress of just such revisional work on American bees.

—C. H. K.

HOW THE COCKROACH DEPOSITS ITS EGG-CASE; A STUDY IN INSECT BEHAVIOR

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It is generally thought that cockroaches which move about for several days with egg-cases protruding from their bodies eventually drop them casually in any moist place. The following observations on the two species of domestic roach, *Periplaneta americana* and *Blatta orientalis*, show conclusively that they do not drop the egg-cases indiscriminately, but usually hide them with great care in crevices, or bury them in soft wood or workable material. Moreover, they almost always cover them precisely with bits of debris, which sometimes they even carry from a distance.[1] Only recently I have been so fortunate as to be able to observe, step by step, these marvelous activities, which are so unlike the stupid, primitive creatures that roaches are generally thought to be.

In the very long time that cockroaches have been on the earth (they are the oldest of living insects), they have acquired behavior patterns which may be classified as clearly instinctive. On the other hand, in their work of safeguarding the egg-case after it has been dropped from their bodies, they solve problems created by unique and unprecedented situations with bits of ingenuity or adaptability which, in all honesty, can hardly be called less than gleams of intelligence. One has only to read the amazing report by Haber (Ent. News, 31: 190–193, 1920) on the performances of a mother American cockroach in caring for her egg-case to concur with this view. In discussing his observations I recently remarked, "One needs only to read the account of Haber to feel that if any insect behavior at all may be called intelligent, this is an example of it." It was largely to verify for myself if these broad remarks were justified that I spent many hours on several nights, closely observing the oviposition of cockroaches. A detailed account of the behavior of one typical mother of each of these two species is here given.

Cockroaches sleep by day and conduct all their activities, including oviposition, under cover of darkness. They are sensitive to light, and the observer bent on prying into their private lives soon learns that they will leave any task to scuttle to cover when the light is turned on. I soon found, however, that they can be conditioned to the rays of a flash-light if the light is dimmed by covering the lens with a thin cloth.[2]

With flash-light in one hand and a large reading-glass in the other, both carefully focused on an insect through the side of the glass box in

[1]The Life History of the American Cockroach, Ent. News 51: 121–124, 151–155, 186–189, 222–227, 273–278, 1940; and The Biology of the Roach, *Blatta orientalis*, Trans. Acad. Sci. St. Louis, 25: 57–79, 1924.

[2]Auditory Perception in Insects with Special Reference to the Cockroach, Quart. Review Biology 15: 121–155, 1940.

which they lived, I was able not only to discern every movement of the insect, but also saw them all magnified to twice their natural size.

THE AMERICAN COCKROACH

With flash-light and magnifying glass, I observed a mother *P. americana* with egg-case protruding from her body (4 A. M. on May 29, room temperature 69 degrees F.) hollow out with her jaws a cavity in the side of an irregular piece of rotted elm wood that lay on the floor of the glass cage. She clung to the side of the wood, head diagonally downward, enlarging a shallow, round cavity a quarter of an inch in diameter. She continued for some time biting away portions of the wood, often stretching her neck to reach a remote part of it.

A tiny pile of sawdust lay on the floor just beneath the hole, and as she worked she brushed together from time to time the new accumulation of chips and dust in the hole, and, with mouth and legs, threw them to the floor. The jobs of excavating the hole and disposing of the litter were slowly and carefully done, although somewhat awkwardly. Often the mother would leave her work, descend to the floor and brush the scattered bits of wood-dust into the pile. She did not use her legs for sweeping, as most insects in a similar situation would have done, but made a brush of her head and mouth-parts, and quickly swept the dust under her body, bit by bit, while slowly she moved backwards.

After digging in this way for half an hour, she rested on top of the wood for several minutes. Finally she walked to the edge of the deepened cavity, stretched her head into it and kept it there for two or three minutes; when she removed it there was a small pool of glistening liquid at the bottom. This material had come from her mouth, but was not the usual thin, black saliva, but appeared to be a more glutinous substance. After she had spat this on the bottom of the hole, I expected oviposition quickly to follow, and in this I was not mistaken. After idling about for a little while, she grasped the wood with her legs, placed her abdomen directly over the cavity and curled it under until the tip with its egg-case was partly in the hole; then with a few convulsive movements of the abdomen she dropped the egg-case into the mass of adhesive material.

At this point let me digress, and add for comparison the behavior of another mother of the same species a few nights later. This one was spitting the secretion, drop by drop, for a period of twelve minutes, into a cavity which she had already made; however, she rolled each drop about in her jaws for several seconds before she permitted it to fall. This manipulation of the saliva made me suspect that she may have been mixing it with some adhesive secretion from glands in the mouth. Her method of dropping the egg-case into the pool differed slightly from that of the first roach. In this case the cavity was on the top of the piece of wood and not in its side, so she did not need to resort to acrobatic contortions to get her abdomen into the cavity. She merely took her position squarely over the hole, curled her back until it formed a circle, and then with several forceful movements of contraction and expansion, lasting perhaps half a minute, she forced the egg-case from her body into the pit.

Now let us return to the first mother, who had gotten so far as to drop her egg-case into the pool and was resting on top of the wood. The piece of wood was small and of light weight, and sometimes when she was digging into it, it rocked back and forth with her energetic movements. Often too, in combats with trespassing sister roaches (these conflicts were nothing more than leg-biting and leg-pulling), the piece of wood would sway perilously. But she was so engrossed in her work that she seemed not at all conscious of the motion—and hardly aware too of the brighter light which now played upon her, for I found that by now I could safely remove the cloth covering from the lens. Suddenly her attention was turned to a comrade who was biting out and carrying away bits of wood from her domain. In the tug-of-war which followed, both cockroaches tumbled to the floor and the piece of wood rolled over and landed with the cavity flat against the floor—I thought forever barring the mother from her egg-case.

After regaining her poise and cleaning her antennae for a few seconds, she went in search of her lost property, finally recognizing it among similar pieces of wood near which it had fallen. She then spent several minutes probing over it with palpi and jaws in search of the opening. Undaunted by failure, she climbed to the top again, and with seeming deliberation she tugged at it this way and that for several minutes, often grotesquely pulling it while still on top of it, and sometimes falling to the floor in the struggle. After several such falls she finally ceased tugging at it and, to my astonishment, climbed on top and resorted to the process of rocking it to and fro; this she continued for several minutes, when suddenly it yielded and rolled over, sending her again headlong to the floor. Nevertheless, she had accomplished what she had attempted, for now the cavity was exposed and the egg-case within it was still in its moorings. The mother easily located the pocket, poked her head into it, and withdrew bringing out the egg-case securely in her jaws.

She set it down carefully near the edge of the hole with the serrated edge uppermost, picked it up again after a few seconds, held it again with the important serrated edge topmost and finally, by stretching her neck far into the cavity, imbedded it carefully, serrated side up, into the pool of glutinous substance. The attention given to the position of the egg-case is evidently due to the fact that the young on hatching emerge only through the serrated edge of the capsule, and to fasten it with that edge downward would spell disaster for the emerging young. The mother had no control over the landing of the egg-case when it fell from her body, but she left no stone unturned until she was sure it was in the right position.

Her work was still far from finished. She now spent several minutes with her head in the cavity, and when she withdrew it the egg-case was completely covered with a layer of glistening moisture. Her next move was to cover it with saw-dust, and this she did by gathering mouthfuls of it from the floor, carrying it to the hole and carefully gluing each load in place until the capsule was entirely covered. She did not throw it in casually, but strained her neck to place each load where she wanted it.

While she was thus occupied, conflicts with other roaches that wandered into her territory again "upset the apple-cart" and the piece of wood again rolled over, but this time without hiding the opening. The hole was now on the opposite side from where it had been, but the egg-case was still accessible. She seemed much perturbed, and attempted to place the piece of wood in its old position by climbing upon it and performing a series of indescribable acrobatic feats; thus she rocked it back and forth for many seconds until finally it regained approximately its original position. This apparently satisfied her, and she resumed the gathering of sawdust which now she merely dumped on top of the egg-case. This process of filling the hole with loose material was in sharp contrast to the precise work of gluing mouthfuls of sawdust all over it, as explained above.

It was five o'clock when I went to bed, leaving her to continue her monotonous work (an hour had elapsed since I had begun watching her). She must have worked on for another hour, for when I returned at sunrise I found the cavity filled to its brim, and when I probed into it with a straw, I found it tightly packed.

Now that we have seen her use the sawdust in the later stages of egg-case concealment, we can better appreciate her persistence in conserving it in a neat pile during the earlier operations. This detail of behavior is not standard, however, for I have seen other roaches of both species, instead of saving the sawdust and brushing it into a pile, go to nearby pieces of wood, clay or cotton wadding and bite away bits to use as covering material, or even plaster the capsule beyond recognition with pellets of roach excrement dissolved in saliva.

Since this roach had been at work for probably a half-hour before I began to observe her, she must have spent at least two hours altogether on the job of attending to the safety of her egg-case.

THE ORIENTAL COCKROACH

It was at 8:30 P. M. on June 26 that I saw a mother *B. orientalis* at work in a shallow tin jelly-glass lid filled with white sand. This lid and sand had been on the floor of the glass box for several months, and from it from time to time I had removed egg-cases that had been glued by the ovipositing females to the bottom and the inner edge of the rim.

This insect, with egg-case protruding from her ovipositor, was in the center of the dish busily sweeping away the sand with her legs, apparently trying to reach the bottom. The legs moved rapidly, and the stream of sand was brushed back in an irregular jet. She used the four front legs in this procedure, but used only two of them at a time, first the two on one side of her body, and then the two on the other. The legs never worked in pairs (*i. e.*, one on each side), and even though two of them moved at one time, they seldom moved in unison. The result was to send a clumsy stream of sand into the air on one side or the other of her body. In this behavior she differed somewhat from the American roach described above, who for a similar job used the palpi and jaws instead of the legs, and thereby sent the dust in a stream under her body to its goal.

After spending eighteen minutes brushing away the sand, she

uncovered the shiny bottom of the tin. Much of this time might have been saved, had she not often strayed from her work to make exploratory excavations in other parts of the tin. When the bottom came into view, she abruptly stopped work, and without loss of time lifted her body high on her legs over the clearing, humped her back into a ring, and then with abdominal contortions which lasted fully a half-minute, forced the egg-case from her body and into the center of the cleared spot. The deliberation with which each move was done indicated that the egg-case was not dropped indiscriminately, but the preparation of the site and the deposition of the ootheca were carefully made.

After dropping the egg-case, she relaxed from her extreme pose and rested for several minutes. Then, turning around suddenly, she placed her mouth to the capsule and spread a thick layer of glutinous secretion all over it; this required about three minutes. She then picked up the egg-case with her jaws, righted its position on the tin so that the serrated edge was uppermost and spent several minutes apparently pressing its seams together by running her jaws back and forth over it, pressing it tightly here and there, all the while spitting saliva over its edge as if knitting and cementing it together, all at one time. Whether or not this extra precaution was necessary I do not know; I had had the impression that the two edges of the seam naturally dovetailed tightly together, and that the seam would split automatically when the expanding nymphs were ready to emerge.

The cockroach spent the next forty-five minutes covering the sticky substance with grains of sand; when she ceased, every portion of the ootheca was completely covered and hidden from view. During this entire period of forty-five minutes, she had never once changed her position; her mouth was always near to the egg-case, and when she needed grains of sand she merely stretched her long neck to one side or the other to obtain them. Moreover, she did not take the first grains of sand that came to hand, for with my magnifying glass I could distinctly see her selecting some and rejecting others. With the aid of her sensitive palpi she discarded the small grains and retained the large ones, holding several of them in her mouth while at the same time selecting others, all the while actively rolling them in her mouth where they became saturated with the fluid. She then glued small mouthful after mouthful carefully in position on the capsule.

At the end of this forty-five minutes of arduous work, apparently she felt that the egg-case was completely disguised, for now she changed her position on the sand and also changed her method of work. By quick movements of the four front legs, in the manner already described for her excavating maneuvers, she directed an avalanche of sand grains in the direction of the egg-case, continuing until after a few minutes it was completely covered. The task was finished, but her frenzied momentum would not permit her to stop; she continued to sweep the sand this way and that for at least a half-hour more, in other parts of the dish where, in my opinion, it could not do the remotest bit of good to the egg-case, unless possibly she was obliterating her foot-prints or odor trails. When at last she stopped to rest, her black body was most amusingly peppered with grains of white sand. Even then she seemed loathe to leave the scene of her work, and spent another hour quietly in the center of the dish.

ANALYSIS OF THE BEHAVIOR PATTERN

Contemplating this picture of cockroach behavior, one is soon aware of certain traits which are (a) outstandingly instinctive, (innate powers or inborn capacities, if one should dislike the term instinct), and other bits of behavior (b) which connote intelligence (and by intelligence I mean the capacity to learn and the ability to adapt learned or instinctive behavior to new situations, as well as the ability to understand situations and to form, as Turner has suggested for ants, "practical judgments"). Then in the border-lands we may ponder over behavior patterns (c) which combine both instinct and intelligence, the one not appearing without the other.

In reviewing examples from each of the three categories, I may cite as instinctive (a), the mating behavior; gregariousness; the shunning of light and seeking of darkness. As exceptional activities extending into the field of intelligence (b), the conserving of sawdust for use at a future time; the persistent and effectual work in turning over the piece of wood so she could reach the hidden egg-case; recapturing the egg-case when it bounded to the other side of the cage, and replacing it in the depression in the cardboard (Haber). As examples of behavior which seem to be a combination of both instinct and intelligence, I may cite (c), retrieving the egg-case after it had been dropped into the viscid liquid and resetting it with the openings topmost; covering the capsule with layers of rust, which must have been difficult to obtain, to render it inconspicuous in its position in the rusty tin lid, when plenty of material of other color was convenient at hand (*op. cit.*); selecting the large grains of sand, and rejecting the small ones to roll in the mouth and glue onto the capsule.

But all of this was anticipated by Dr. Wm. M. Wheeler when he says, in speaking of insects other than cockroaches, "Most of the activities can readily be interpreted as chain-reflexes, or 'instincts' in the usual biological sense of the term. They are relatively fixed or stereotyped and undoubtedly hereditary and therefore represent the most ancient and most solidified complex of the behavioristic cycle. But there stand out from this complex many activities which are much less mechanized and of such a nature as to demonstrate that the wasps (insects) possess emotions and associative memory, that they exercise discrimination and choice, that they learn by experience, and form habits in the restricted sense of the term and that they can modify their behavior adaptively in response to unusual stimuli on the basis of previous experience and therefore behave, to a limited extent, like intelligent beings."[3]

The concise epigram by Remy de Gourmont is apt in this connection: "One would attribute to the instinct, the series of acts that conserve the present state of a species; to the intelligence, that which tends to modify the state."

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[3]Introduction to "Wasp Studies Afield," pp. 5–6, 1918.

DIMORPHISM IN THE FEMALE HONEYBEE (APIS MELLIFERA L.): DEVELOPMENT OF THE METATHORACIC TIBIA[1]

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The dimorphism existing between the two female castes of the honeybee (*Apis mellifera* L.) represents a conspicuous example of the effect of environment upon insect development. The mechanism by which female larvae are differentiated into queens and workers is assumed to be determined by the food and care received during the larval period, because it is generally accepted that all female larvae have similar genetic constitutions and that such ecological factors as temperature and relative humidity are similar during the development of both castes.

Larvae receive royal jelly, a glandular secretion of the nurse bees, for 2 days after hatching, and then the diet of the workers is changed, but the queens continue to receive the secretion. Chemical analyses have demonstrated that royal jelly contains many of the known nutritive substances required by animals for growth, maintenance, and reproduction—proteins, carbohydrates, fats, minerals, vitamins, and water. Melampy and Jones (1939) have shown that royal jelly from queen cells containing larvae 3 to 4 days old has the following approximate chemical composition: moisture 66 per cent and dry matter 34 per cent, the latter consisting of protein 36, fat 16, total reducing substances (calculated as glucose) 37, ash 2.4, and undetermined material 8.6 per cent. Royal-jelly protein has a digestion coefficient of 81 per cent and a biological value of 75 per cent, indicating that it is of considerable value in the building of body tissue. Royal jelly is a good source of vitamin B_1 but contains no demonstrable amount of vitamins A, C, or E. The fact that it contains little, if any, of these vitamins indicates either that the queen bee does not require these accessory factors or that the amounts present are too small to be detected.

On the assumption that pollen and nectar are the only foods provided the worker larvae after the change in diet, it may be suggested that this diet has either specific nutritional deficiencies or it cannot be sufficiently utilized by the larvae to meet genetic requirements for growth. Of course, pollen and nectar are considered the principal foods of the adult worker caste, and they apparently meet the require-

[1]A contribution from the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, in cooperation with Louisiana State University.

ments for adult maintenance as well as for the secretion of royal jelly and wax, but it is well known that the nutritional needs of adult animals are quite different from those of the rapidly developing young of the same species. Chemical studies have been made on worker food by von Planta (1888) and Koehler (1922). However, the biological value of the worker diet should be determined in order that comparisons may be made with the diet of the queen.

Von Rhein (1933) has reported that presumptive queen larvae are fed a special secretion, in addition to royal jelly, which determines their future course of development, but this observation has never been confirmed. Heyl (1939) and Townsend and Lucas (1940) suggest that royal jelly contains a gonad-stimulating substance which may be associated with caste differentiation. However, Melampy and Stanley (1940) were unable to find a substance in royal jelly which causes follicle stimulation in the white rat. After reviewing some of the literature, Haydak (1939 and 1940) postulated that the female dimorphism is the result of a differential secretion of one or more hormones by the developing larvae of the two castes, but he did not consider the factors that initiate this difference.

This paper reports a study of the dimorphic development of the tibia of the metathoracic leg of the two female castes in the honeybee. In the worker caste the outer surface of the tibia of the metathoracic leg is smooth and concave and has no setae, but is fringed with long setae which curve outward and slightly over the naked surface, the arrangement being commonly known as the corbicula, or pollen basket (fig. 3). The corresponding surface of the tibia of the metathoracic leg of the queen is characterized by the absence of such a modification (fig. 1). Since honeybees are specialized feeders, this adaptation is important to the nutritional economy of the colony, as it is used by the workers to transport pollen to the colony. Casteel (1912) has made an extensive study of the pollen-gathering behavior of the worker honeybee, as well as observations upon the morphological structures involved.

The purpose of this investigation is twofold: (1) By studying the setae on the tibia of the metathoracic leg, to secure information on the sequence of events in the development of a body structure that may serve as a basis for experimental inquiry into the time of determination of a dimorphic caste character in female honeybees; (2) to obtain more detailed information as to the developmental morphology of this structure for pollen gathering, because of the importance of honeybees in the pollination of plants useful to man.

MATERIALS AND METHODS

The workers used in this study were taken from several colonies of Italian bees. Larvae and pupae of known age were obtained by permitting the queen to oviposit for 24-hour intervals on dated brood frames. The immature queens were produced by transferring newly hatched female larvae to queen cells and allowing them to develop in queenless colonies.

Observations were made upon three general sorts of material—living metathoracic legs, permanent mounts *in toto*, and serial sections. Pre-

liminary studies were made upon living legs of all stages. The appendages are easily removed, even from larvae, by placing the insect, with its ventral side up, in a physiological salt solution and making a slit in the larval cuticula over the pair of legs. Interval pressure is sufficient to cause the limbs to slip out through this incision, where they may be easily clipped off. Alcoholic Bouin's solution was used as a fixative. The whole mounts were stained either with Conklin's haemotoxylin or with borax carmine followed by bleu de Lyon. The former stain acted more quickly and gave more uniform results, but it had the disadvantage of giving greater opacity. The latter stain often made brilliant preparations, staining the hypodermis red and the setae blue, but on the whole the reaction was less uniform. To stain entire legs after pupation, it was necessary to peel off the pupal cuticula, which is impermeable to most stains. The serial sections were cut at 15 or 20 microns and were stained with Delafield's haematoxlyin and eosin.

RESULTS

Since both queens and workers develop from similar eggs and since both castes receive similar food and care through the second day of larval life, the origin and early development of the legs are alike in both castes. Leg rudiments make their appearance during early embryonic development. In embryos 44 to 46 hours old the anlagen of the legs are visible, and by 60 to 62 hours they are clearly seen as three pairs of evaginations from the ventral body wall of the thoracic segments (Nelson, 1915). At about the time of hatching the body wall folds over them and encloses them in a peripodial pouch. In later development the distal ends of the legs extend from the pouches and the tips of each pair grow toward the median ventral line, where they touch (fig. 4). The legs do not invaginate during development, and their surface is therefore never entirely inverted, as is typical for the imaginal discs of the Diptera (Weismann, 1864). They lie right side out, folded beneath the cuticle, and extend from the pouches which enclose their proximal ends.

In the larva the hypodermis of the tibia is folded into large, loose undulations (the primary folds) caused by the crowding of the legs into a confined space. The day before pupation the primary folds are replaced by tightly folded secondary pleats, the axes of which lie at right angles to the long axis of the tibia (fig. 12). From sections (fig. 9) it may be seen that the basement membrane does not parallel the contours of the surface, but that alternating rows of tall and shorter cells allow the surface to be raised up into more distinct contours than that of the underlying membrane. At pupation the secondary folds are smoothed away by the extension of the limbs, just as the wrinkles in a balloon are obliterated by its inflation. The hypodermal pleating is obviously a mechanism prepared in advance which permits the sudden lengthening of the leg at the time of pupation.

Earlier than the day preceding the fifth larval molt, pupal cuticle is not clearly present on the distal ends of the hypodermal cells, and whole legs stain easily. Late in the day of pupation stains will not penetrate the surface; sections through legs at this time show the presence of a thin cuticle, thereby giving physical as well as histological

evidence that the cuticle of the pupa is secreted during the pupal period. The surface of the pupal cuticle is marked off into polygonal areas, each unit corresponding to the end of one cell. Within each of these sculptured spaces is a hooklike extension, which is a characteristic feature of the pupal cuticle.

A few days before pupation a large and a small spur are formed at the distal end of the tibia of the third leg, on the anterior, inner side. They are simple evaginations of the hypodermis, and the pupal cuticula is molded over their surface. Figure 12, which was drawn from the outer surface, shows only the larger of the two spurs.

The day following pupation the hypodermis retracts from the pupal cuticle and forms a subcuticular space which is filled with a liquid. The spurs are completely reduced, but their original shape is detectable in the overlying cuticle, where they serve as convenient points to be grasped with tweezers when the pupal cuticle is peeled away in preparation for staining. It would appear that the adult cuticle is in the process of formation during the second day following pupation, for after the first day the surface of the leg again becomes impermeable to ordinary stains.

Two days before pupation the nuclei of the hypodermis are nearly spherical and are of approximately the same size. They are crowded so close together that they almost fill the entire thickness of the epithelium from the basement membrane to the surface (fig. 6). The cell walls which

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EXPLANATION OF PLATE I

All figures, except fig. 4, drawn with aid of camera lucida.

Fig. 1. Lateral view of right leg of adult queen honeybee. ×13. 2. Section through tibia of worker pupa (9–10 days) in which pupal cuticula has been removed. Outer, or corbicular, surface, which is on right side, is free from setal cells. ×64. 3. Lateral view of left leg of adult worker. Note single large seta arising from corbicular surface. ×13. 4. Diagram of ventral half of a transverse section through larva showing relation of imaginal legs to body wall. 5. Transverse section through tibia of queen pupa (7–8 days) in which pupal cuticula has been removed. Lateral hypodermis, which is placed on right side, contains setal cells. ×64.

Abbreviations used on figures

AU	Auricle	NV	Nerve
AT HYP C	Attenuated hypodermal cell	OEN	Oenocyte
BC	Blood cell	OES	Oesophagus
B M	Basement membrane	PC	Pecten
CB	Corbicula	PD MB	Peripodial membrane
CLA	Claw	PUP CUT	Pupal cuticula
F	Femur	S BR C	Smaller bristle cell
F C	Fat cell	SC FL	Secondary fold
HM SN	Hemolymph sinus	SLK GL	Silk gland
HYP C	Hypodermal cell	S M	Sinus membrane
HYP CB	Hypodermis of corbicula	SP	Spur
HYP N	Hypodermal nucleus	1 TAR	Basitarsus or planta
HYP O	Hypodermis of outer side of tibia	5 TAR	Fifth tarsal segment
IM LEG	Imaginal leg	TB	Tibia
INT S	Intercellular space	TMG	Tormogen
L BR C	Large bristle cell	TR	Trachea
M B	Muscle bundle	TRG	Trichogen
		V NV CD	Ventral nerve cord

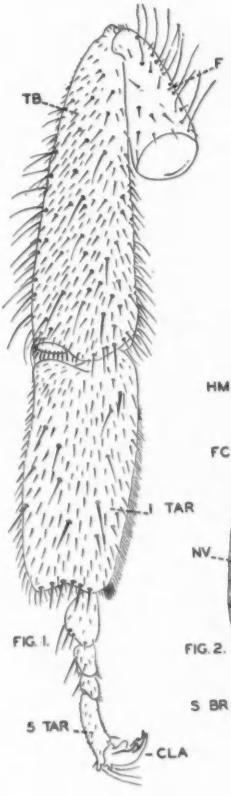

FIG. 1.

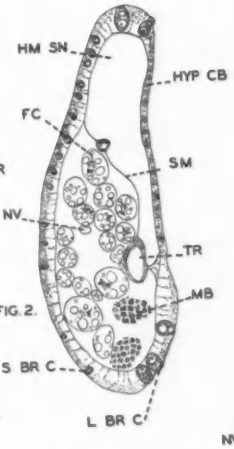

FIG. 2.

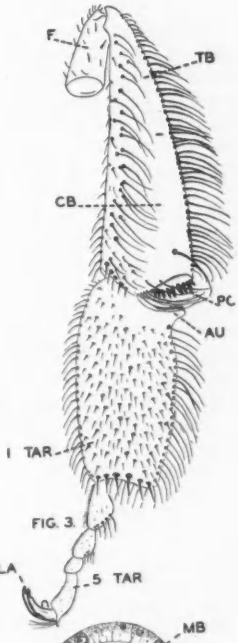

FIG. 3.

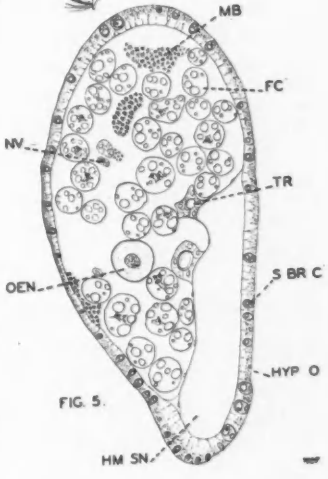

FIG. 5.

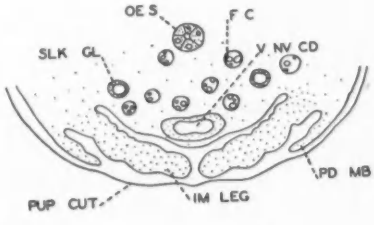

FIG. 4.

lie between the nuclei are not visible at this time; therefore, it is impossible to know whether the hypodermis is histologically a true stratified epithelium or a pseudostratified type; however, it is probable that in early stages the latter description may be the true one. A change in the position of the nuclei occurs in the hypodermis of the legs on the second day before pupation. Late in this day an increase in the area of the hypodermis permits the cells to form a single columnar layer, and the nuclei are near the basal ends of the cells. The cytoplasm surrounding them is dense and stains darkly, whereas in the distal ends the cytoplasm is clear (fig. 7). Later in the same day the nuclei are found in the center of the cells, and shortly before pupation they and the darkly staining cytoplasm are next to the distal wall of the cells, whereas the cytoplasm near the basement membrane is then clear. The pupal cuticle is formed during the period of migration of the nuceli.

From the time of pupation the hypodermis of the leg is a tall, simple, columnar epithelium; however, it has a distinctive appearance because the cells are long and stringlike. The cytoplasm surrounding the nucleus is dense and is applied to the external surface of the tibia, the distal ends of the cells being nearly contiguous (fig. 11). The remainder of the cell is attenuated into a thin, lumpy thread, which reaches to the basement membrane (fig. 10). Between the stringlike proximal ends there is considerable intercellular space that is filled with a fluid, possibly hemolymph, which shows a slight reticulation upon fixation. The strings are longest at the edges of the corbicular surface of the worker tibia.

The important difference in morphology between the queen tibia and that of the worker is the occurrence and distribution of the setae; the typical pattern is shown in figures 1, 2, 3, and 5. In the honeybee, as is typical of other insects (Snodgrass, 1935), each large seta is characterized by two special cells at its base, from which it is formed. The cell that gives rise to the seta is the larger and lies deeper in the hypodermis; it is called the trichogenous cell, or trichogen. The second, smaller cell lies above the larger; it surrounds the base of the seta and is called the socket cell, or tormogen (fig. 10).

Two days before pupation the nuclei of the tibial hypodermis have a uniform appearance. However, during this second day before pupation the nuclei assemble in the half of the hypodermis next to the basement membrane, and approximately 24 hours later several mitotic cells in

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EXPLANATION OF PLATE II

All figures drawn with aid of camera lucida. For key to abbreviations used, see Explanation of Plate I

Fig. 6. Section of tibial hypodermis of queen larva 5 days old, showing nuclei throughout entire thickness. ×715. 7. Section of tibial hypodermis of worker larva, in middle of its seventh day, showing nuclei close to basement membrane. ×715. 8. Section of tibial hypodermis of worker larva in later part of its seventh day, showing mitoses. ×715. 9. Transverse section through two secondary folds in hypodermis of worker larva 8 days old. ×715. 10. Section through large pair of setal cells and adjacent hypodermal cells from tibia of worker pupa (9–10 days). ×715. 11. Surface view of tibial hypodermis of young worker pupa (8–9 days), drawn from whole mount. ×375. 12. Lateral view of tibia of worker 8 days old, a few hours before pupation, with hypodermis bearing secondary folds. ×50.

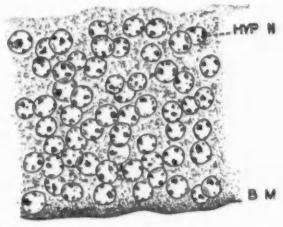

FIG. 6.

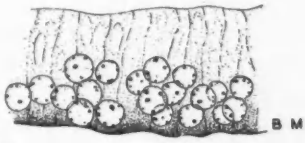

FIG. 7.

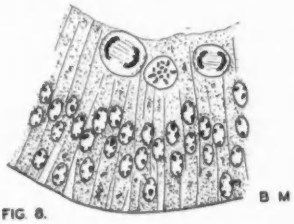

FIG. 8.

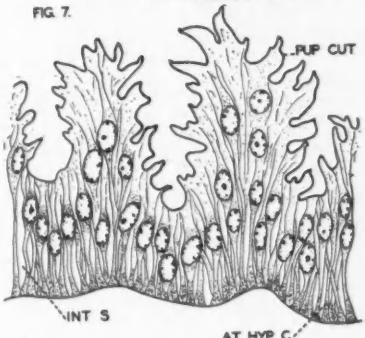

FIG. 9.

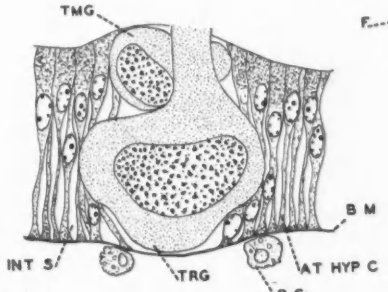

FIG. 10.

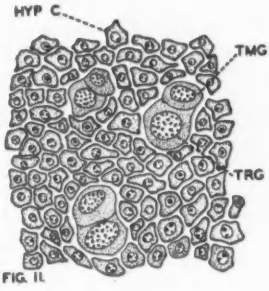

FIG. 11.

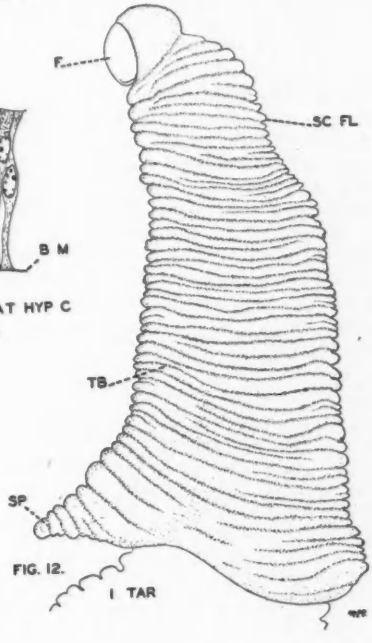

FIG. 12.

various stages of mitosis are found in the clearer outer cytoplasmic portion (fig. 8). It is probable that the trichogen and tormogen of a setal pair are the result of the division of one of these hypodermal cells. The mitotic spindle is usually oriented in a plane parallel to the surface, but after telophase the two daughter cells shift their position so that one, the tormogen, comes to lie above the other, the trichogen. A line drawn through both cells would be nearly perpendicular to the surface. The trichogen becomes larger than the tormogen, and from the former a process of cytoplasm extends through the tormogen and beyond the hypodermal surface. This process becomes a seta, and cuticle is deposited upon its surface during later stages of development. The pairs of setal cells of both queen and worker fall into two distinct size categories. The average diameters of the trichogens and their nuclei of the larger pairs are 264 microns and 198 microns, respectively, whereas the trichogenous cells in the smaller pairs have average cell diameters of 132 microns and nuclear diameters of 99 microns. The larger pairs are thus twice as large as the smaller. The size of the setae produced varies roughly with the size of the cells. The cytoplasm of the setal cells is dense and homogenous, and the nuclei are more evenly granular than those of the surrounding hypodermal cells (fig. 10).

When the two castes are considered separately, it is evident that the development of the hypodermis and its related structures on the tibia of both occurs during a 4-day period. In the queen this period occurs from about the fifth through the eighth day, and in the worker from the seventh through the tenth. Prior to this there is no evidence of seta formation and the tibiae are morphologically similar in both castes. Pupation occurs within this period. It would appear that pupation is the important factor in each case, for when the time of pupation is changed in either direction, the whole period is moved forward or backward accordingly. Because of the nature of the manipulation necessary to produce queens experimentally, the time at which they pupate is more variable than it is in the worker. In this work the pupation of the queen was observed to occur late in the sixth day, and at other times in the seventh. The important fact, however, is the event of pupation, for this process is the result not of a chronological age, but rather of a definite physiological threshold and morphological attainment.

The chief differences between the two castes as regards the differentiation of the tibia may be enumerated as follows:

Queen.—On the day before pupation (6th) the hypodermal nuclei undergo migration, mitotic figures lie next to the cuticula on both the outer and inner surfaces of the tibia, the pupal cuticle begins to be formed, and the secondary folds are produced. On the day of pupation (7th) the adult size of the leg and the definitive number of setal cells is reached. On the day after pupation (8th) the hypodermis retracts from the pupal cuticle, the setal processes grow from the trichogenous cells, and the imaginal cuticle begins to be produced.

Worker.—One day before pupation (7th) the hypodermal nuclei migrate, and mitotic cells are present at the surface except on the outer side of the tibia, which will be the corbicula. On the day of pupation

(8th) but before it occurs, the definitive number of setal cells is attained and the secondary folds are produced. The day after pupation (9th) the hypodermis retracts from the pupal cuticle and the processes that will form the setae extend from the trichogens. On the second day after pupation (10th) the setae attain their full length and the cuticle of the adult begins to be secreted.

The presence or absence of setae from the outer surface of the metathoracic tibia is the basis of the dimorphism of this segment. The first evidence of setal formation is the occurrence of the pairs of larger cells in the hypodermis. In the queen these cells are found on both the outer and inner surfaces of the tibia by the time of pupation (6th or 7th day of larval life), and in the worker they are found on the inner side of the tibia by pupation (8th day); but at no time during development are they found in the outer, corbicular surface. The establishment of the characteristic setal pattern is manifest a day earlier in the queen than in the worker, but in both it bears the same time relation to pupation.

Before this investigation was started it was thought that in early stages setae might be found developing on the outer as well as on the inner surface of the worker tibia, and that in later differentiation the primordia on the corbicular surface would regress so that no setae would be produced by them. This was not found to be the case, however, for from the time setal cells could first be distinguished from other hypodermal cells, the future corbicular surface appeared free from them.

DISCUSSION

In this study of the development of the setae present on the metathoracic tibia in the queen and the worker honeybee, it was observed that the events are the same, their order of occurrence is alike, and even the time sequence is similar, the most conspicuous difference being that the events occur about 2 days earlier in the queen. These observations upon morphological structures in development are in close agreement with physiological data, which show that the worker caste is characterized by a retarded devlopment. A biochemical study of the differentiation of the female honeybee has shown that queens and workers have approximately the same growth rate during early larval life, and that later the growth of the worker caste is retarded, as shown by the nitrogen, total lipid, total reducing substances, and calorific value (Melampy, Willis, and McGregor, 1940).

In addition to the nutrition of the larvae, which has been discussed, it might be suggested that differences in rate of development could be partly responsible for the dimorphism existing between the two female castes. Recently Goldschmidt (1938) reviewed an extensive literature which demonstrates that often the developmental cause of phenotypic variations can be assigned to differences in the rates at which growth processes occur. It might, then, be suggested that the dimorphism of the tibia could be a result of the two rates of development which the two castes are known to possess. Melampy and Willis (1939) have shown that the developing queen caste possesses a higher metabolic rate than does the worker. The oxygen consumption and the carbon dioxide production of the queen decrease during the period of bristle formation,

whereas during the comparable stage of the worker the metabolic rate remains relatively constant, but at all times lower than that of the queen. Although the cause of this difference in rate is not temperature, because the two castes develop under the same colony conditions, it would be of interest to know if, by increasing the rate through experimental raising of temperature, presumptive workers might be made to complete their development in a less workerlike condition than they would have normally. Von Rhein (1933) concluded from experiments with temperature that the rate of development had no effect on the attainment of dimorphism in the honeybee. Even if these results should be later disproved, it is to be remembered than in the colony the normally existing difference in metabolic rate between the two castes may be basically initiated by a nutritional deficiency.

The adult worker and the queen may be considered to be the two extreme expressions of a like, or at least a very similar, gene complex because they arise from similar eggs. During the first 48 hours after hatching the female larvae are capable of developing into either queens or workers. This undetermined condition is utilized in the commercial production of queens by transferring 1- or 2-day-old larvae from worker cells to queen cells, in which they are permitted to complete their development in queenless colonies. Zander and Becker (1925) claim that a critical period occurs between 78 and 90 hours. Before this period female larvae are equipotential with respect to their adult caste; after this period they can develop only into the worker caste. Queens reared from larvae transferred during the critical period develop into "intercastes." It seems evident that female honeybees follow a single course of development. In offspring from a homozygous queen the dimorphism would, indeed, represent a development of two distinct phenotypes from the same genotype.

The ontogeny of any animal comprises a series of restrictions in potency due to successive determinations of its parts to follow only certain lines of development. In the honeybee such a series of determinations includes the establishment of the primary axes of the egg, the limiting of parts of the blastoderm to form certain embryonic structures (12 to 24 hours, Schnetter, 1934 a and b), and the restriction of a part of the embryo to form the metathoracic legs of the imago (before 44 hours, Nelson, 1915). But the most important determining process with respect to the present study is the one imposed upon the imaginal leg rudiments, which limits the destiny of the tibia, deciding whether they will form the worker or the queen dimorphic character. The time when this determination becomes established is not yet known, but the data presented in this paper indicate that it must occur between the second day of larval life and the second day before pupation.

Even though 2 days before pupation the tibia of the two castes are so similar histologically that they are indistinguishable, it cannot be supposed that the event of determination has not already occurred by that time. For, as Woodger has pointed out, although "two entities are manifestly, i. e., observably, non-different, we cannot infer that they are not intrinsically non-different" (quoted from Needham, 1936, p. 75). Later transplantation experiments with the limb rudiments

should reveal more exactly the time of determination of this caste character. Even when this is accomplished, however, it will not follow that all the dimorphic traits are also determined at that time.

SUMMARY

The developmental morphology of the metathoracic tibia, with respect to its dimorphic structure, in the two female castes of the honeybee (*Apis mellifera* L.) has been studied. The characteristic setal pattern for each caste is already established by the time the setal anlagen are first histologically evident. The events of hypodermal differentiation associated with setal development are coincident with pupation. In both castes the setae appear above the surface of the hypodermis the day after pupation. Possible mechanisms involved in caste production in the female honeybee are discussed.

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A NEW SPECIES OF CHLORION FROM CUBA
(Hym. Sphecinae)

H. T. FERNALD,
Winter Park, Fla.

Chlorion (Isodontia) bruneri n. sp.

Body golden pubescent on clypeus, frons about up to the eyes, on the cheeks, horizontal part of the neck, on top of the collar, prothoracic lobe, sides and back part of mesonotum, traces on the female scutellum, postscutellum, a large spot above base of hind coxa joining its mate on the other side, a band from below the fore wing down along the episternal suture, another from the hind coxa to near the base of the hind wing and extending backward above to the propodeal spiracle. Pilosity golden, dense, particularly long on frons, sides of the body and on the legs. Head, body and petiole black; abdomen rather dull ferruginous with scattered darker shades. Coxae, trochanters and more or less of the femora black, strongly pilose.

Female.—Head: Clypeus somewhat swollen medially its entire length, its lower margin ferruginous, rather broad, particularly laterally, reflexed and projecting to form a tooth on each side of a broad central notch. Ocelli prominent, forming a much flattened triangle. Scape, pedicel and part of the first filament segment ferruginous, remainder black. Mandibles 3-toothed, ferruginous to the bases of the teeth which are black; with numerous long golden hairs near their bases.

Thorax: Collar narrow, front to rear, rising sharply from the neck. Mesonotum with a median depressed line on its front half; its surface with numerous medium sized punctures and minutely aciculate. Scutellum the same. Postscutellum entirely covered with pubescence and pilosity. Propodeal dorsum finely punctured between very small, closely packed transverse ridges; its end concealed by pubescence, with a rather deep fovea; sides with punctures and ridges like the dorsum. Metapleuron with small punctures where not covered by pubescence. Mesopleuron practically all covered by the pubescence. Petiole black, as long as, or slightly longer than the hind coxa and trochanter together, with many long, slender, golden hairs on its front third.

Abdomen dark ferruginous with many scattered darker shades, its surface above made sericeous by closely lying, whitish, very short hairs; below with scattered punctures and long, ferruginous hairs, mostly near the lateral margins of the ventral plates; last plate with numerous punctures.

Wings very slightly fuliginous; veins dark yellowish; 2d. and 3d. cells of fore wing very wide laterally.

Legs ferruginous except black coxae, trochanters and dark shades

on the femora; these with many long, golden hairs; rest of the legs pale ferruginous, heavily sericeous in places; spines pale ferruginous; claws large, as long as the tarsal segments they join; their basal half or more ferruginous and the outer parts and teeth black.

Male.—Clypeus with a slightly thickened lower black border which projects somewhat downward toward its middle where there is a slight depression. All parts of the antennal filament black. First abdominal segment partly black or dark; last plate above truncate behind; entire upper surface minutely sericeous, or if hairs are absent, reticulate; with numerous longer hairs particularly toward the sides on the last four plates; last ventral plate broadly rounded, broadly, slightly emarginate medially; with lateral clusters of rather long hairs on all the plates and rather dense bands of shorter ones across the last four plates. Femora black almost to their tips; claws all black; coxae, trochanters and femora heavily pilose, the femora and tibiae golden sericeous at certain angles; spines darker than the legs; last tarsal segment black or very dark. Otherwise as in the female.

Holotype: One female marked only "Cuba." *Allotype:* one male marked "Viñales 4–6–9–22 col. S. C. B. y J. A." Taken at Viñales, Cuba, April 6–9, 1922, by S. C. Bruner and J. Acuña. These types will be deposited in the U. S. National Museum. This species is named in honor of the collector of the allotype, Mr. S. C. Bruner, of the Estacion Agronomica, Santiago de las Vegas, Havana, Cuba.

This species resembles members of the subgenus *Ammobia* in its general stoutness of body, abundance of pilosity and pubescence, and in the presence of a part of a stigmatal groove, though some other species of *Isodontia* also have traces of this. But the absence of a tarsal comb in the female, the much greater width than height of the second cubital cell and the presence of short, three-toothed mandibles seem to place it as certainly an *Isodontia* rather than an *Ammobia*. It may be considered as the *Isodontia* nearest to *Ammobia* just as *Ammobia lucae* is the *Ammobia* nearest to *Isodontia*. These facts seem to indicate that the two subgenera have only rather recently been developed from a common ancestor and that some of the species have not as yet diverged strongly.

AMERICAN BUTTERFLIES AND MOTHS, by CECILE HULSE MATSCHAT, illustrated by Rudolph Freund. 70 pages 9 x 11¼ inches. 1942. Published by RANDOM HOUSE, New York. Price $1.00.

This book is intended primarily to introduce these insects to nature lovers. It contains a general discussion of the structure, habits, and methods of collecting butterflies and moths, and presents a brief account of 73 common species. Each account consists of common and scientific name (with a pronunciation of the latter), a very brief description of the adult and caterpillar, and comments on the species. The book is excellently illustrated, with 14 full-page color plates and many sketches in black and white (though the only references to the illustrations are in the index).

This is a very attractive book, and one which should serve its purpose in arousing the interest of non-entomologists in this group of insects. Unfortunately, it appears to have been poorly edited, as we noticed some misspelled words, and a few of the illustrations are incorrectly labeled.—D. J. B.

NOTE ON THE MALE GENITALIA OF CERTAIN ISODONTIA. (Hym.: Sphecidae)

RICHARD DOW,
Reading, Mass.

Several years ago Mr. S. C. Bruner loaned to me for study a male wasp which Dr. H. T. Fernald has just described in the preceding paper, and designated as the allotype of *Chlorion* (*Isodontia*) *bruneri*. Though the specimen superficially resembled *costipennis* (Spinola), its three-toothed mandibles indicated that it might be an undescribed form of the group including *harrisi*, *elegans*, and *auripes*. The specimen was forwarded to Dr. Fernald, who agreed that it probably represented a new form, and found that he had a similar female in his collection, also from Cuba. When he recently declared his intention to describe these specimens, and asked for the return of the male, again in my hands, I wrote asking his permission to make a study of the male genitalia. The present note is the outcome of that request.

Because the Cuban specimens had three-toothed mandibles, I selected *harrisi*, *elegans*, and *auripes* as suitable for comparison. Acting upon a suggestion of Dr. Fernald, I included *costipennis* as well. This is a species with two-toothed mandibles, of which I studied five specimens collected in various parts of tropical America from Mexico to Brazil. I found that the genitalia of *costipennis* were obviously different from those of the group with three-toothed mandibles. The paramere, though similar in general shape, has a slight instead of pronounced twist at the apex. When it is viewed from an angle perpendicular to its greatest width, the apex is seen to be abruptly pointed, the ventral margin curving toward the tip at a point opposite instead of anterior to the strongest curve in the dorsal margin (see fig. 5). Whereas in *harrisi* and its allies there is a characteristic bevel on the inner surface of the paramere, defined by the ventral margin of the paramere and a mesal ridge which follows the ventral boundary of the thinly sclerotized area, in *costipennis* this bevel, at least toward the apex, is weakly developed. Furthermore, there is a distinct difference in the prominence of the group of thick, tapering hairs situated on the outer surface along the ventral margin anterior to the apical curve. Though variable in size and number, in *harrisi* and its relatives these conical hairs are more or less obscured by other, more slender hairs in the same general area. In *costipennis*, however, they stand out very clearly because the slender hairs are less abundant, and taken as a whole, not so long.

The examination of the genitalia of one male of *exornatum* (Fernald) from Tampa, Florida, which I happened to study because of its being incorrectly identified as *auripes*, showed that the above distinctions may have wider significance than at first appears and may be correlated, at least in part, with the two- and three-toothed condition of the mandibles. The parameres of this specimen of *exornatum* (a species with two-toothed mandibles) differ from those of the *costipennis* I have

studied in that the area on the outer surface above the large conical hairs is densely instead of sparsely haired, the hairs being longer than in *costipennis*, and also in that, posterior to the curve of the ventral margin, the bevel is sharply defined. Nevertheless, on the basis of the genitalia

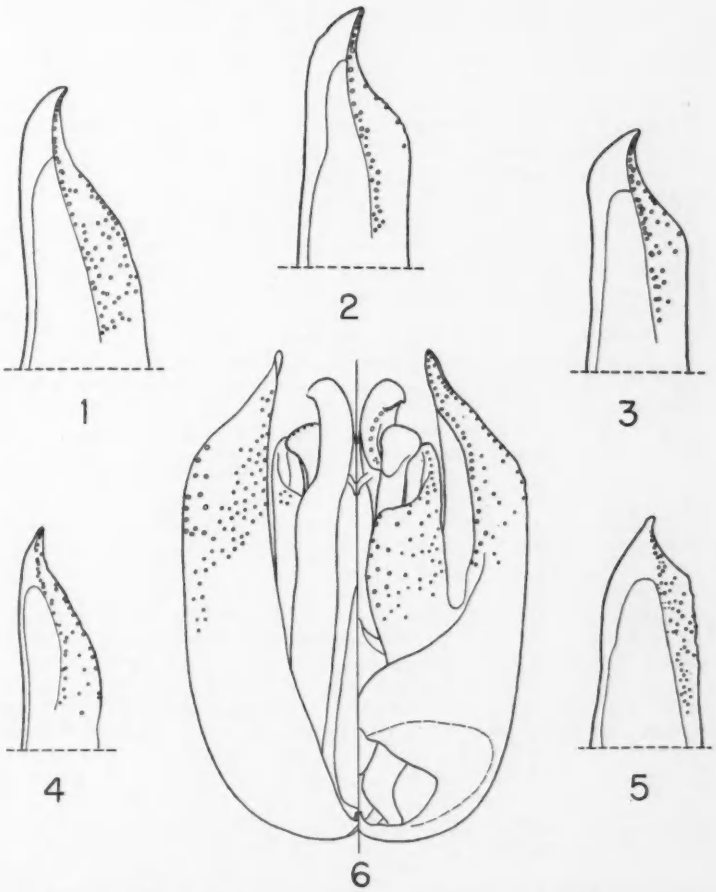

FIG 1. Apical half of left paramere (inner surface) of *Chlorion* (*Isodontia*) *auripes*, White Plains, New York. 2. Same of *Chlorion* (*Idodontia*) *bruneri*, allotype, Viñales, Cuba. 3. Same of *Chlorion* (*Isodontia*) *harrisi*, Tampa, Florida. 4. Same of *Chlorion* (*Isodontia*) *elegans*, Umatilla County, Oregon. 5. Same of *Chlorion* (*Isodontia*) *costipennis*, Prieta, Honduras. 6. Male genitalia of *Chlorion* (*Isodontia*) *bruneri*, allotype, Viñales, Cuba. Left half, dorsal surface; right half, ventral surface. The basal ring is omitted, but its attachment is indicated by the interrupted line on the ventral surface of the base of the paramere.

as a whole, there is no question that this specimen belongs in the same group as *costipennis*.

Though I have studied only four *harrisi*, five *elegans*, and four *auripes*, besides the allotype of *bruneri*, all the specimens of these forms with three-toothed mandibles were found to have nearly identical male genitalia, the most significant differences appearing to lie in the shape of the paramere. This structure, however, is so twisted toward the apex and assumes such a variety of positions in cleared material that until it is dissected from the remainder of the genitalia and so mounted that at least the apical half lies perfectly flat, its use to separate the forms is practically out of the question. Even then, although the distal half has a more or less characteristic outline (see figs. 1–4), the differences seem to be in the nature of variations which are only partially correlated with the named forms. For example, in a test in which I attempted to conceal the identity of the mounted parameres, one specimen of *harrisi* was placed as *auripes* because it lacked the sharp angle in the ventral margin, and the separation of the specimens of *elegans* and *auripes* was not only dubious but incorrect. The paramere of the allotype of *bruneri* appears to lie within the limits of variation of that of *harrisi*.

Other attempts to find distinctions in these genitalia were equally disappointing. Take, for example, the measurements given in the following table.

	Length of paramere divided by greatest width of lamina volsellaris				
bruneri	6.4				
harrisi	5.5	6.0	6.2	7.2	
elegans	5.7	6.0	6.2	6.3	7.1
auripes	5.1	5.6	5.8	6.1	

From these negative results I am forced to conclude that the genitalia of the single available specimen of *bruneri* do not offer a valid basis for its separation from the North American forms with three-toothed mandibles, especially *harrisi*.

I am much indebted to Mr. Bruner, Dr. Fernald, and various members of the Bureau of Entomology and Plant Quarantine for favors received during the preparation of this note.

HANDBOOK OF ECONOMIC ENTOMOLOGY FOR SOUTH INDIA, by T. V. Ramakrishna Ayyar. Pp. xviii and 528, illust. 1940. Published by Madras (Superintendent, Government Press). Price Rs. 4. 12. 0.

The author of this volume, T. V. Ramakrishna Ayyar, was for some time Government Entomologist of Madras, India. He has brought together facts from his previous publications and has rounded out a general volume on the economic entomology of South India. In a general way this volume succeeds "Some South Indian Insects" by T. Bainbrigge Fletcher which appeared in 1914. The first part of the volume of eighty-five pages covers general entomology, while the second part of 450 pages deals with economic insects and problems. (From the Proceedings R. E. S., London.)—C. H. K.

FEEDING HABITS OF THE SOUTHERN ARMYWORM AND RATE OF PASSAGE OF FOOD THROUGH ITS GUT

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In a recent article (Crowell, 1941) the writer reported his findings on the utilization of certain foodstuffs by larvae of the southern armyworm. The work was done with larvae reared in the Department of Zoology and Entomology at the Ohio State University under the conditions developed and described by Waters (1937).

The present paper deals with observations made on such physical activities as the ingestion and passage of natural food matter through the alimentary canal of southern armyworm larvae.

FEEDING HABITS

The southern armyworm is a very general feeder, the foliage of certain legumes and crucifers being particularly preferred. Out of curiosity, milkweed and tobacco foliage were given larvae in the laboratory. It was found that larvae of several instars would feed on the tobacco leaves, but only those of the sixth and last instars would eat milkweed, and then only sparingly.

In the experiments described below, the first leaves arising from the cotyledons of cranberry beans (London Horticultural Variety) were used as food for the larvae. These leaves are succulent (89% water content), nutritious, and are devoured with avidity by all instars of the southern armyworm.

Observations were made through a binocular microscope (90x) on the feeding of newly hatched larvae from an egg mass placed on the surface of a bean leaf. At this magnification the pubescence of the leaves is strongly apparent. It was observed that the larvae feed for several hours on the spines and hairs making up this pubescence. Later, before entering the second instar, the larvae feed on the leaf tissue between the veins, usually leaving intact the epidermis on the other side of the leaf. Larvae of later instars eat more and more of the whole leaf until, in the sixth instar, even the primary veins are consumed. Larvae of the fifth and sixth instars usually start the consumption of a leaf at its margin, the crescent shape of the devoured area being characteristic of leaf-eating larvae.

Lepidopterous larvae have been described as continuous feeders. This assertion is not exactly correct. Extended observations of undisturbed, normal southern armyworms showed that they alternate feeding periods with periods of quiescence. These resting periods are quite distinct from the long quiescent stage prior to molting from one instar into the next.

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Preliminary observations were made on three larvae at different times and record was made of the time when feeding started and stopped and the moments when defecation occurred. This record in graphic form appears in figure 1. The sections representing feeding and resting periods are labeled as such, and the times of defecations are denoted by broken cross-lines with the letter "D" inserted. Absolute times are marked off in hours and 7½ minute intervals.

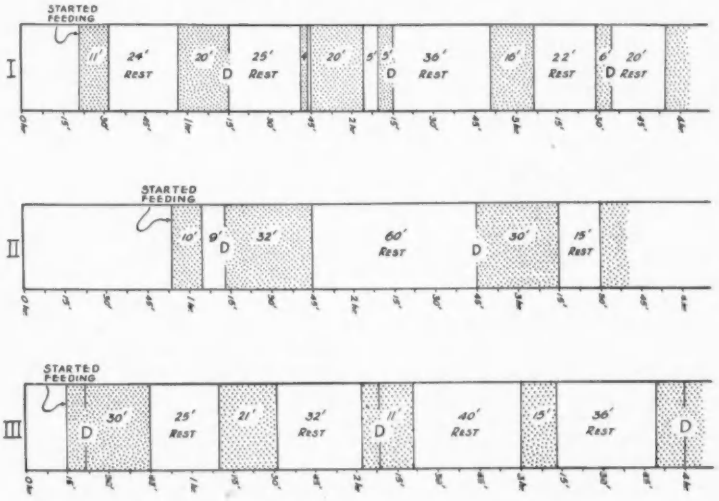

Fig. 1. Graphic representation of the periods of resting and feeding of three sixth-instar larvae of the southern armyworm over a period of about 4 hours. The broken cross-lines marked "D" represent times of defecation.

From this graph it can be seen that the resting periods of these three larvae are as important (judging solely from their frequency and duration) as the feeding periods in the physiology of the insect. With larvae I and II the acts of defecation seem to be connected in some manner with the change from a period of feeding to one of resting or vice versa. With larva III, however, the acts of defecation had no apparent connection with other activities of the insect.

The foregoing 4-hour observations suggested the desirability of repeating the observations over a 24-hour period as follows:

Methods.—Three larvae of the 5th instar and three of the 6th were taken from the general culture in the act of feeding. One of the 5th instar larvae later proved to be too old as it ceased feeding preparatory to molting three hours before the experiment was completed. These six larvae were then placed in Petri dishes containing fresh bean leaves and so arranged on a table that they, together with a thermometer and a clock, could be watched continuously without undue strain on the part of the observer. A desk lamp was kept burning throughout the 24-hour period. The temperature ranged between 22° and 26° C.

The experiment was started at 6:30 A. M., March 28, 1940. Observations were almost continuous, the writer being relieved for several hours by his wife. Twice during the 24 hours the covers of the Petri dishes were removed carefully in order to add fresh leaves and remove fecal matter.

Results and Discussion.—The data collected are arranged in two tables. In Table I are presented the comparative figures and averages of the lengths of time spent in the feeding and resting periods and in periods of wandering around. The average length of a wandering period was not considered significant since these periods did not occur at all with two larvae and were generally very irregular.

TABLE I

THE RELATION OF LENGTH OF TIME SPENT IN FEEDING, RESTING AND WANDERING OF SIX LARVAE OF THE 5TH AND 6TH INSTARS OF THE SOUTHERN ARMYWORM OVER A 24-HOUR PERIOD

Larva	Instar	No. of Eating Periods	Total Eating Time	Average Eating Period	Total Resting Time	Average Resting Time	Total Wandering Time
			Min.	Min.	Min.	Min.	Min.
1	6	30	766	25.5	669	23.6	5
2	6	26	609	23.4	831	32.0	0
3	6	36	868	24.1	572	16.3	0
4	5	25	238	9.5	1029	34.3	173
5	5	22	509	23.1	681	29.6	22*
6	5	35	596	17.0	754	22.2	90

*During the last 228 minutes of the 24-hour observation period, this larva was quiescent, preparatory to molting into the sixth instar.

In the sixth instar larvae No. 1 and 3 spent more time in feeding than in resting; the 5th instar larvae all spent more time in resting than in feeding.

The relation of defecations to the resting and feeding periods is presented in Table II.

TABLE II

THE RELATION OF DEFECATIONS TO FEEDING, RESTING AND WANDERING PERIODS OF SIX LARVAE OF THE 5TH AND 6TH INSTARS OF THE SOUTHERN ARMYWORM OVER A PERIOD OF 24 HOURS

Larva	Total No. of Defecations	No. During Feeding Periods	No. During Resting Periods	No. at End of Feeding Periods	No. at End of Resting Periods	No. During Wandering Periods
1	16	4	4	4	4	0
2	12	8	2	1	1	0
3	16	10	2	3	1	0
4	8	1	2	1	3	1
5	12	4	2	0	6	0
6	13	3	2	3	4	1
Totals.....	77	30	14	12	19	2

Most of the defecations take place during the process of feeding and the next largest number falls at the termination of resting periods. There appears to be no connection between defecation and the beginning or ending of feeding.

Under constant artificial light no diurnal cycle of feeding-resting ratios was observed during the 24 hours. In other words, the feeding-resting periods were about the same day and night.

RATE OF PASSAGE OF FOOD THROUGH THE ALIMENTARY CANAL

In studies of the utilization of food it is important to know the length of time required for the passage of food through the alimentary tract of the experimental animal. In the case of southern armyworm larvae, with their straight-tube digestive tracts, it was assumed to be a relatively short period of time.

Methods.—For the purpose of determining the rate of passage of ingesta, an indicator was needed for earmarking ingested food. Several dyes were tried, but the results were always obscured by the diffusion of the indicator throughout the food. A paste, made from powdered Bentonite clay and juice from crushed bean leaves, was tried with some success. As soon as a larva was observed to be eating the paste, the clock time was recorded, the larva allowed to feed for five or ten minutes, and then the paste replaced with fresh leaves. Observations were made every few minutes until a defecation finally showed the presence of the light colored clay. The results from several of these tests showed that the late sixth instar larvae pass food through their entire alimentary canal in about 3¼ hours.

When tried on a larger scale with both 5th and 6th instar larvae, certain difficulties arose. The 5th instar and early 6th instar larvae did not feed freely on the indicator paste until starved for two or three hours. This condition of partial starvation was not desirable, and the question also arose as to the effects of clay diet, even of short duration, on the natural functioning of the alimentary canals of these larvae.

It has been found (Crowell, 1941) that the larvae utilize little, if any, starch from their natural food. This fact, together with the knowledge of the color reaction between starch and iodine, led to the use of powdered potato starch as the indicator material.

The starch flour was dusted upon bean leaves which had been previously sprayed lightly with water. Larvae of the 5th and 6th instars were taken from the general culture and allowed to feed for several minutes on the treated leaves, the clock time being recorded. The larvae were then transferred to fresh, untreated leaves in Petri dishes and observed. The time of each defecation was recorded. The fecal pellets were then dispersed in a few drops of dilute iodine in KI solution and examined under the binocular for the presence of starch granules.

Results.—The results showed evidence of churning action in the gut of these larvae. From the tightly packed appearance of the food observed in the mid- and hind-guts of dissected larvae, one might imagine that the starch ingested in these experiments would pass

through the alimentary canal in a mass, emerging at last completely enclosed in one or two fecal pellets. Actually, the starch indicator particles were found dispersed throughout a series of fecal pellets evacuated during a five hour period, after the first appearance of the starch. However, the dispersal of the starch granules in these pellets was not uniform, but reached a maximum concentration in about the third pellet defecated and tapered off during the next 4 or 5 hours. Only four larvae were observed until the time of the complete disappearance of the starch granules. Table III shows the elapsed times to the first appearance of the indicator, to the maximum amount, and to the final elimination of the indicator from the alimentary canal.

TABLE III

THE RATES OF ALIMENTATION OF SEVERAL LARVAE OF THE 5TH AND 6TH INSTARS OF THE SOUTHERN ARMYWORM

Exp. No.	No. of Larva	Instar	Time Till First Trace of Indicator		Time Till Maximum Test		Time Till Elimination of Indicator	
			Hr.	Min.	Hr.	Min.	Hr.	Min.
1	1	5th	2	29	3	19	..	..
	2	6th	2	10	4	13	..	..
	3	6th	1	50	3	10	..	..
	4	5th	1	10	2	15	..	..
	5	6th	1	25	..	..	..	..
	6	5th	2	10	2	40	..	..
2	1	6th	2	55	4	10	..	..
	2	6th	3	40	..	..	6	56
	3	6th	2	3	3	8	8	3
	4	6th	1	18	4	17	..	..
	5	6th	1	10	3	5	..	..
	6	6th	2	3	3	33	..	..
	7	6th	1	52	2	53	6	12
	8	6th	1	44	2	44	7	54
Averages....	.....	.....	2	0	3	17	7	18

It is obvious that observations on the rate of passage of food that are based on the detection of an indicator in the feces cannot help showing considerable variation due to the different degrees of fullness of the recta of the experimental animals at the time of ingestion of the indicator material. The time elapsed for the egestion of the maximum amount of starch indicator, about 3¼ hours, is possibly the most accurate figure obtained for the rate of food passage through the alimentary canal of the southern armyworm. It is interesting to note that this average time agrees perfectly with the preliminary results obtained with the clay and leaf juice paste indicator mentioned earlier in this paper. The clay was possibly too heavy or compact to be dispersed among the leaf fragments to any great extent by whatever churning action may occur in the alimentary tract of these larvae.

BEAN LEAF INGESTA IN THE FORE-GUT

In dissections of southern armyworm larvae it was noticed that the fore-gut usually contained only the green leaf juice, the leaf particles themselves having passed on into the mid-gut. The green fluid which the larvae regurgitate when disturbed is apparently this same leaf juice from which the solid matter has been removed.

For use in further investigations of the fore-gut activities, a number of 6th instar larvae were selected at random from the general culture. These were placed in Petri dishes with fresh bean leaves and observed. After several individuals had fed continuously for 10 or 15 minutes, they were removed carefully, so as to prevent regurgitation, killed instantly in hot water and dissected immediately under water. Other individuals were allowed to remain in the dishes until they had entered the resting period between periods of feeding. Some were killed and dissected at various periods of time after entering the resting stage, while others were observed until they showed signs of resuming feeding again. At this time they were removed and killed for dissection before they had had time to take more than a bite or two.

The larvae killed and dissected while still in the process of feeding were found to have their fore-guts filled with leaf particles, as was to be expected. The fore-guts did not appear to be as tightly packed with leaf particles as were the mid-guts, but this condition could be partially due to the absence of the confining peritrophic membrane which allowed the leaf particles to float out into the dissecting fluid when the gut was opened.

Every larva killed and dissected at the moment it showed signs of resuming feeding again was found to have no solid particles of leaf matter remaining in its fore-gut. This region of the alimentary canal, however, always contained a good supply of leaf juice. As there is no way of telling how long a given larva will remain quiet before commencing to feed again, it was impossible to determine at just what time in the resting period the food particles are all transferred from the fore-gut into the mid-gut.

The fact that the larvae pass the leaf particles on into the mid-gut and retain much of the liquid in the fore-gut may possibly be explained in the following manner: As the food material within the peritrophic membrane of the mid-gut moves slowly along, it is replaced with the freshly eaten material from the fore-gut by peristaltic action. Here the leaf particles become confined by the peritrophic membrane, but the leaf juice, liberated in some quantity in the process of masticating the rather succulent leaves, is free to pass back again through the oesophageal valve into the fore-gut.

The fact that all leaf particles were observed to have been passed on into the mid-gut before any of the larvae commenced feeding again after a rest period suggests a plausible answer to the alternation of resting and feeding periods. The larvae ingest food faster than it can be digested and passed out of the intestine, a natural condition with most animals when given an unlimited food supply. After feeding for a time, the stimulation of back-pressure from the packed mid-gut and irritation of food particles in the fore-gut causes them to enter a resting

period. Removal of this pressure and irritation sets off the stimulus to commence feeding again.

SUMMARY

1. Observations are given on the general feeding habits and type of food plants eaten by the southern armyworm.

2. Continuous observations on feeding larvae of the 5th and 6th instars show that during a 24-hour period the larvae spend as much, if not more, time in resting or quiescent stages as they do in feeding periods. These resting periods alternate with the feeding periods and are entirely separate from the quiescent stages prior to molting or pupating. The moments of defecation are most common during the feeding periods and at the termination of resting periods, but also occur at other times.

3. A method for the determination of the length of time required for the passage of food through the alimentary canal of the larvae is described. The 5th and 6th instar southern armyworm require about 3¼ hours for the main bulk of an earmarked quantity of food to pass through the digestive tract.

4. The fore-guts of the larvae are cleared of solid leaf particles during rest periods, but retain much leaf juice at all times. An explanation of the alternation of feeding and resting periods based on these observations is submitted.

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MONOGRAPH OF THE WEST INDIAN BEETLES OF THE FAMILY STAPHYLINIDAE, by RICHARD E. BLACKWELDER. 1943. pp. 1–658; 19 maps, 3 figs. Published by SMITHSONIAN INSTITUTION, U. S. National Museum, Bull. 182.

This complete work was made possible by the Walter Rathbone Bacon Scholarship administered by the Smithsonian Institution. In addition to twenty-one months in the islands collecting specimens, the author examined numerous collections and all authentic West Indian records to date are included.

The study includes 91 genera, 6 of which are new to science, and 468 species, 212 of which are described as new. Keys are given to 12 subfamilies and to genera and species. Descriptions and synonymy of all species are given. Nineteen full page maps showing collecting areas are included and, unfortunately, only three cuts showing 17 genitalia figures.—J. N. KNULL.

SWIMMING AND BURROWING ACTIVITIES OF MAYFLY NYMPHS OF THE GENUS HEXAGENIA[1]

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The fact has already been established by bottom fauna studies (Adamstone, 1924; Rawson, 1930; Neave, 1932) that lake dwelling species of *Hexagenia* are inhabitors of soft, organic muds of deeper-water areas contiguous to the shallower sandy or rocky littoral region. Although specimens may be found on a sandy bottom or on a bottom of fine sand and mud intermixed, by far the greater numbers occur on bottoms of a distinctly soft, muddy character. As no investigations have been made on the ability of *Hexagenia* to burrow in various kinds of bottom, and since the character of the bottom is considered by the writer to be of primary importance as a factor influencing distribution of these nymphs as found in Douglas Lake, Cheboygan County, Michigan, a series of experiments was conducted.

FREE-SWIMMING ACTIVITIES

Hexagenia nymphs are not strong, agile swimmers. Their swimming ability is easily shown by artificially circulating the water in an aquarium containing specimens. The nymphs appear passively rheotropic, orienting themselves as best they can facing against the current, at the same time performing the characteristic swimming movements and even then they are carried along almost completely at the mercy of the current. In swimming the nymphs hold the fore legs together anteriorly. The fore tarsi touch each other on the median line just anterior to the mandibular tusks. The middle legs are directed anteriorly, held close to the sides of the thorax and head, and overlap the bases of the fore legs. The hind legs are directed posteriorly, and are held arch-like, but closely pressed to the dorsum of the first three abdominal segments, and the distal tips of the femora almost touch over the middorsal line. The head and thorax are usually arched ventrally thus causing the anterior portion of the body to be directed downward. In a dish containing water this usually results in the nymph constantly striking the bottom of the container or swimming along with the fore legs touching and with the waving abdomen at a slight angle above the bottom. The nymph may turn to the right or left by tilting the body slightly toward the opposite side. Should the nymph in swimming turn entirely over on its back, it leaves the bottom and comes toward the surface. This tilting or turning over of the body at times results in a circular or corkscrew path. If the nymph, while swimming in a straight line, elevates the head and thorax slightly, the course changes to upward or becomes parallel to and just above the bottom. The lateral tails, ordinarily spread apart at about a 45° angle with the

[1]Contribution from the Biological Station and Department of Zoology, University of Michigan.

median line when the nymph is at rest, appear to be a distinct aid in swimming. During the first swimming movements the outer tails are brought together toward the median one thus causing the setal fringes of all three to overlap and forming a more proficient propelling structure. The bringing together of the lateral tails seems to be carried out by intentional muscular movement on the part of the nymph preparatory to swimming and is not due wholly to current pressure from the sides of the nymph as it passes through the water. Swimming is accomplished through strong dorso-ventral undulations of the abdomen. The abdomen was not observed to sway laterally.

The gills are waved during swimming. These waves begin anteriorly and progress posteriorly. The gill movements made in swimming are not identical to those made while the nymph is resting. In swimming the gill motion appears to be a result of abdominal movements as a whole and not due to contractions of the gill muscles used to move them when the body is at rest. The gills do not extend laterally at right angles to the body when the nymph is at rest or swimming, but are directed upward and curved posteriorly straight back over the abdomen or slightly toward the middorsal line.

BURROWING ABILITY

A large, deep aquarium containing water was supplied with soft bottom mud from about 13 m. depth and allowed to settle. The resulting bottom deposit was then further consolidated by gently jarring or shaking the aquarium from side to side. As a result the heavier particles settled through toward the bottom while the lighter, more or less flocculent materials remained near the top, thus more closely simulating natural conditions in the lake. After the mud had thoroughly settled and the surface-water had cleared, a number of nymphs, one-half to three-fourths grown, were introduced and their activities observed. These nymphs immediately settled gently to the surface of the mud and began swimming by means of strong, undulating, dorso-ventral movements of the abdomen. The fore and middle legs were held together anteriorly, and the head and thorax were directed downward. While swimming in this manner the body is so tilted that the anterior end is slightly lower than the posterior, consequently, entrance into the mud was made. Digging motions by the fore legs were then begun, and the strong, steady, undulating abdominal movements ceased, except for occasional waves which propelled the nymph forward at intervals after the way had been cleared by the fore legs. The gills were kept in constant motion during the digging process, producing a current of water which passed posteriorly over the body and out through the burrow opening. Mud particles thrown backward by the fossorial legs were picked up by this current and transported from the burrow. After burrowing to a depth of 10–15 cm., most of the digging movements were suspended and only gill motion continued. As long as the legs were in motion the sides of the burrow constantly caved in and the loosened particles were carried out by the water current. This caving in subsided as soon as the leg movements ceased. However, the mud in front of the nymph continued to be drawn backward over the gills by the current and carried out through the burrow

opening behind the insect. The gill movements at this time became perceptably stronger, thus causing the mud particles directly in front of the nymph to be drawn toward it and swept by the current over its back. As this process continued, a caving in of the mud from the surface along an upwardly curved line was initiated. A current of water was finally produced in front of the nymph along this curved line which cleared a passageway in the mud and formed the anterior portion of the burrow. The water current also provided the nymph with a source of oxygenated water. The front and back ends of a burrow were easily distinguished since the former had a smoothly rounded edge, while the posterior one had a small mound of mud surrounding it. Branches from the original burrow were made in much the same manner. Nymphs were not observed to leave their burrows to come to the mud surface either during the day or at night. Attempts to make artificial tunnels in the mud by the insertion of various objects met with no success, for as soon as the object was withdrawn, no matter how slowly and gently, the sides immediately caved in. A short time after a nymph had deserted a burrow for a branch or if gill movements were suspended for a time, collapse of the walls occurred. The burrow was cleared of mud again when gill movements were resumed.

In order to determine the ability of nymphs to burrow into various kinds of bottom found in Douglas Lake, the following experiments were performed:

Experiment No. 1.—Clean sand, collected near the shore line, was placed in a large culture dish and covered with water. Several medium-to large-sized nymphs were introduced into it. They immediately began the typical swimming movements as described above, trying to gain entrance into the sand. All efforts to penetrate the sand were futile and, as the nymphs grew progressively tired, swimming gradually slowed down and finally ceased. They remained quiet for a short time, moving the gills intermittently and making no effort to hold to the sand with their claws. They were easily pushed to one side or turned completely over by another nymph swimming by and usually made no effort to right themselves at the time. After some time, swimming was resumed and further burrowing efforts were made. Some nymphs would occasionally stop swimming and begin digging with the fore legs, pushing the sand grains laterally. However, very little headway was made due to the constant tumbling of the sand grains back into the small depression as it was deepened. A solid footing for thrusting the head into the depression could not be obtained on the loose sand. Undulations of the abdomen were of no aid to the nymph in forcing the anterior portion of the body into the sand.

When a small stone (1–3 cm. diameter) was placed on the sand, a nymph coming in contact with it began to burrow. By the united efforts of digging with the legs, thrusting the head under the stone by abdominal movements, pushing downward with the dorsum of the thorax braced against the underside of the stone, and pushing with the hind legs, a cavity was made sometimes large enough to conceal only the head and thorax leaving the abdomen exposed, at other times large enough to conceal the entire body of the nymph. The nymph then remained in this cavity for a time, usually making no further attempts to burrow. Another nymph, trying to burrow in the same

place, either forced the first one to leave its burrow or caused it to move further on under the sand until it was no longer under the stone. In this event the latter did not remain completely submerged but came close enough to the surface so that the gills were exposed and might be moved freely leaving the rest of the body still covered by a thin layer of sand grains. A nymph covered in this manner remained thus for some time but would ultimately break out and begin swimming around the dish again in seeming effort to find a more suitable environment.

If covered artificially with sand, a nymph usually remained quietly submerged for a short period and very little if any gill movement was observed. Finally digging started and the nymph came up near the surface of the sand as described above. When covered by a thick layer of sand, the nymph did not escape by digging and soon died.

Experiment No. 2.—In order to determine if the size of sand grains were significant in the ability of the nymphs to burrow, some of the sand from the first experiment was sorted by means of a 35 mesh (opening 0.417 mm.) Tyler Standard Scale screen into two grades: (1) sand retained by the 35 mesh screen, and (2) sand which passed through it.

TABLE I

PHYSICAL ANALYSIS OF BOTTOM MATERIALS, EXPERIMENT NO. 3

Sample of 500 cc. washed through a set of 6 Tyler Standard Scale screens. Measurements of wet volume. Loss in washing, 35 cc.

Meshes per Inch	Size of Mesh in mm.	Materials Retained by Screen in cc.	Percentage of Total	Materials
4	4.699	2	0.4	Shells and sticks
8	2.362	4	0.8	Large marl flakes
14	1.168	18	3.6	Mostly marl flakes
35	0.417	128	25.6	Coarse sand and marl
65	0.208	275	55.0	Fine sand and marl
100	0.147	33	6.6	Very fine sand and marl
Pan	.....	5	1.0	Finest sand and marl

It was found that nymphs could not burrow into either of these two grades of clean, sorted sand. Their reactions on both grades were the same as described in the first experiment.

Experiment No. 3.—Since nymphs were sometimes found in more or less sandy areas in shallow water, their burrowing ability in this type of bottom was tested. A sample of sand was collected at a depth of 1.5 m. from a place where the nymphs were known to occur. Nymphs were placed on this sand in a large culture dish containing water. They had some difficulty burrowing into the sand but all of them finally gained entrance and remained under it. From one end to the other, the burrows were made almost entirely by digging with the fossorial legs and were relatively short and shallow. The time required to complete a burrow was longer than it was for those made in mud. A 500 cc. sample of this sand was then graded by means of a set of six Tyler Standard Scale screens in order to determine more exactly the composition of the sand. From the data given in Table I, it may be seen that the principal constituent, other than sand, is marl.

That sand and marl retained by the 35 mesh screen and that which passed through were used for further experiments. It was found that nymphs could burrow very readily into the fine sand and marl which passed through the 35 mesh screen. However, only about 50 per cent of the nymphs placed on coarse sand and marl retained by the 35 mesh screen could burrow into it by deliberate digging movements.

Clean sand was placed in a dish and covered with a layer of marl. It was found that nymphs burrowed into the marl but not into the sand layer below. If the same sand and marl were intermixed, the nymphs burrowed readily into the mixture.

Experiment No. 4.—Between the sandy bottom in shallow water and the muddy bottom of deep water, a zone occurs in which the sand and mud are intermixed, and the mud forms a comparatively thin layer on top. Dredgings were taken in this intermediate zone at 6–10 m. water depth. This material was placed in a dish containing water and the sand settled quickly to the bottom allowing a layer of mud to form on top. When nymphs were placed on this sandy mud, they burrowed into it readily. A 500 cc. sample of this same mud was graded using the

TABLE II

PHYSICAL ANALYSIS OF BOTTOM MATERIALS, EXPERIMENT NO. 4

Sample of 500 cc. washed through a set of 6 Tyler Standard Scale screens. Measurements of wet volume. Loss in washing, 56 cc.

Meshes per Inch	Size of Mesh in mm.	Materials Retained by Screen in cc.	Percentage of Total	Materials
4	4.699	3	0.6	Wood
8	2.362	4	0.8	Wood, shells, stones
14	1.168	6	1.2	Wood, small stones
35	0.417	140	28.0	Coarse sand, organic debris
65	0.208	253	50.6	Fine sand, organic debris
100	0.147	27	5.4	Very fine sand, organic debris
Pan	.....	11	2.2	Finest sand, organic debris

Tyler screens. The results are given in Table II and show that finely divided organic detritus is the main constituent other than sand.

Clean sand was then placed in a dish and covered with a layer of mud with no intermixing of the sand and mud. Nymphs placed on this burrowed into the mud but only one specimen was observed to enter the sand layer. When this same sand and mud were thoroughly mixed, nymphs easily burrowed into it.

DISCUSSION

The series of experiments described above show that the character of the bottom is one of the most important environmental factors influencing the distribution of *Hexagenia* nymphs.

Morgan and Grierson (1932) seem to have definitely established experimentally that the tracheal gills of *Hexagenia recurvata* Morgan are respiratory organs and that nymphs from which the gills had been removed showed little or no efforts to burrow but remained on the surface of the mud. Wingfield (1939) in his discussion of the experi-

mental work on the respiratory function of the tracheal gills of mayfly nymphs, stated that, "nothing is known of any relation between function and habitat."

At least two important functions of the gills of *Hexagenia*, besides respiration, have been brought out in the author's experimental work. First, they are used indirectly to build the anterior portion of the burrow made in mud and to keep the entire passageway clear of mud particles once it is built. The fact that the walls of the burrow begin to collapse after gill movements cease seems to indicate that the integrity of the burrow is somehow dependent upon the current of water. It may be true that in the natural environment the compactness or adhesive quality of the mud is sufficient to sustain the walls of the burrow at depths greater than 8–10 cm. from the mud surface. However, the uppermost stratum of mud in Douglas Lake is almost always composed of flocculent, semisuspended particles which do not possess the compactness of the deeper mud. Second, the gills insure a more or less steady supply of oxygenated water for use in respiration. The oxygen supply in the water surrounding the nymph would undoubtedly be rapidly exhausted were it unable to renew the supply of water. It was stated under Experiment No. 1 that when a nymph was covered by sand, the gills did not move freely. This was due to the weight of the sand particles which constantly fell back onto them almost as soon as they were pushed away; consequently, the nymph was forced to come to the surface or suffocate. In Morgan and Grierson's work, it may be that the reason the nymphs made no effort to burrow after their gills had been removed was because they had no means of obtaining a fresh supply of water in the burrow and would therefore suffocate. Also, without gills they would have no way of keeping the burrow clear, even if they could build it.

It is known that the nymphs of *Hexagenia* do not occur in the profundal regions of Douglas Lake (Eggleton, 1931), and they do not extend beyond 15 m. depth. This is also substantiated for other large bodies of water in the bottom fauna studies of Adamstone (1924), Rawson (1930), and Neave (1932). One of the significant reasons for this limited depth distribution seems to be indicated by the dissolved oxygen relations in the South Fishtail depression of Douglas Lake. From the physico-chemical data published for Douglas Lake by Welch (1928), and Welch and Eggleton (1932; 1935), it may be seen that in the South Fishtail depression, beginning about the first of July and continuing through the summer, the normal limits of the thermocline vary within about 12 to 16 m. In these data it is also shown that there is a distinct and rapid drop in the dissolved oxygen content of the water between the upper and lower limits of the thermocline, the oxygenless zone usually beginning at about 20 m. Thus, there appears to be a correlation of the habitat occupied by the nymphs (11–13 m.) with the limits of the thermocline and the amount of dissolved oxygen present. From the selected data given for the years 1929–1933 (Welch and Eggleton, 1932; 1935) the average drop in dissolved oxygen within the thermocline limits was 4.4–1.4 cc. per liter. Therefore, at depths greater than 15 m. the nymphs in their burrows would have difficulty obtaining sufficient oxygen from the available water. The character of the bottom materials beyond 15 m. is not

sufficiently different to lead one to the conclusion that this alone would preclude the nymphs from migrating into greater depths.

The preceding experiments also show that the nymphs cannot burrow into clean sand taken from the wave-washed area just below the water line but can burrow into marly or muddy sand taken at greater depths. When the marly and muddy sand grains were carefully examined under a microscope, their otherwise smooth surfaces were found to be coated with a thin layer of either marl or fine particles of mud. Thus, the marl and mud appear to act as binders or adhesives holding the grains in place and preventing them from falling back into the burrow once it is cleared. In the instance of the clean, more or less smooth sand grains there is nothing to hold them in place after they are piled up during the digging process. Consequently, they fill the depression as fast as it is dug. Tables I and II show that by far the greater proportion of the sand-marl or sand-mud was of the finer type, and therefore more suitable to the nymphs for burrowing than the coarse sand-marl or sand-mud. The fact that when the clean sand was mixed with either marl or mud, the nymphs could readily burrow into it further supports the conclusion that marl or mud affects the character of the sand in some way which renders it suitable for burrowing.

SUMMARY

1. Free-swimming and burrowing activities of *Hexagenia* nymphs are described in general.

2. Gills are used for burrow construction and to maintain a more or less constant current of water through the burrow once it is built.

3. Burrowing experiments performed with nymphs on various kinds of bottom show that the character of bottom is one of the most important factors influencing distribution of *Hexagenia* nymphs.

4. The greatest water depth at which *Hexagenia* nymphs occur in Douglas Lake is correlated with dissolved oxygen relationships within the thermocline.

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THE ARANEIDA FOUND ON COTTON IN CENTRAL TEXAS

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While working for the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Division of Cotton Insect Investigations, at Waco, Texas, the writer encountered numerous species of spiders in examining cotton for insect damage. Most of these spiders are little known and receive only casual notice. Some of them were found to be predators on insects which damage the cotton plant or its fruit.

The predatory habits of spiders are beneficial in the control of insect pests and when spiders are found in large numbers in an area of great insect population, it is only natural to suspect that the spiders are feeding on the insects and decreasing the population. Bishop and Hart (1931) found spiders of the family Lycosidae feeding on mosquito larvae. Jones (1940) observed spiders of the genus Dictyna eating craneflies and leaf hoppers. Bilsing (1920) found that *Adelphocoris rapidus* (Say) was eaten by spiders in the families Lycosidae, Attidae, Clubionidae, Pisauridae, Agelenidae and Epeiridae.

The writer did not find any species of spider feeding on the boll weevil (*Anthonomus grandis* Boh.) which would indicate that this insect's hard body covering and large size was too difficult for most spiders to overcome. The smaller cotton pests which have softer body coverings were, however, found to be attacked. The following table shows the spiders observed feeding on cotton insects.

TABLE I

SPIDERS OBSERVED FEEDING ON COTTON INSECTS

	Adelphocoris rapidus (Say)		*Psallus seriatus* Reuter		*Aphis gosypii* Glover	*Heliothis armigera* (Fab.)	*Alabama argillacea* (Huebner)
	Adults	Nymphs	Adults	Nymphs	Nymphs	Larvae	Larvae
Misumenops celer	.....	.....	x	.....	.....	x	x
Misumenoides aleatorius	x	.....	.....	.....	.....	x	x
Argiope aurantia	.....	x	x	.....	.....	x	.....
Tetragnatha laboriosa	.....	.....	x	.....	x	.....	.....
Phidippus variegatus	x	.....	.....	.....	.....	x	x
Wala palmarum	x	x	x	x	.....	.....	.....
Aysha gracilis	.....	.....	x	.....	x	.....	.....
Mimetus hesperus	.....	.....	x	x	x	.....	.....
Oxyopes salticus	x	.....	x	.....	.....	.....	.....

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List of Spiders collected from cotton during the Summers of 1941–42.[2]

DICTYNIDAE

Dictyna segregata Gertsch and Mulaik
Dictyna longispina Emerton

MIMETIDAE

Theridion murarium Emerton
Latrodectus mactans Fabricius

MICRYPHANTIDAE

Grammonota texana Banks

ARGIOPIDAE

Neoscona eximia Gertsch
Neoscona minima Cambridge
Neoscona vertebrata McCook
Acanthepeira stellata Walckenaer
Eustala anastera Walckenaer
Tetragnatha laboriosa Hentz
Argiope aurantia Lucas
Mangora gibberosa Hentz
Mimognatha foxi McCook
Gea heptagon Hentz
Aranea sp.

OXYOPIDAE

Peucetia viridans Hentz
Oxyopes salticus Hentz

CLUBIONIDAE

Chiracanthium inclusum Hentz
Clubiona kagani Gertsch

ANYPHAENIDAE

Aysha gracilis Hentz

THOMISIDAE

Misumenops celer Hentz
Misumenops dubius Keyserling
Misumenoides aleatorius Hentz
Xysticus funestus Keyserling
Philodromus infuscatus Keyserling
Ebo sp.

SALTICIDAE

Phidippus texanus Banks
Phidippus variegatus Lucas
Paraphidippus marginatus Walckenaer
Metaphidippus insignis Banks
Metaphidippus vitis Cockerell
Sassacus papenhoei Peckham
Wala palmarum Hentz
Pellenes coronatus Hentz
Marpissa undata DeGeer

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[2]Collections were made in Falls, McLennan and Limestone Counties.

THE CRAYFISHES OF FLORIDA, by HORTON H. HOBBS, JR., Pp. v and 179, 24 pls. (346 figs.), 8vo., 1942. Paper bound. Published as Vol. III, No. 2. Biological Science Series of University of Florida, Gainesville, Fla.

We call attention to this monograph, an excellent and thorough-going piece of work which is well illustrated, because it reviews, pages 9–22, practically all the important work that has been done on distribution, migration routes and ecological areas in the peninsula of Florida and its source of faunal supply to the southern Georgia coast. Odonatists have recognized for some time that Florida had a pocket fauna of endemic species. It is a vacation ground for collectors. Distribution of insects there and the origin of the peculiar species are rapidly becoming a marked minor problem in insect species study. The pages cited state the parts of the problem and cite the literature on the subject.

Incidentally it brings back those thrills of boyhood days when another kind of crayfish had just been pulled out of a hole or had been captured under a chunk in a bottom-land slough. And then the first sight of cave crayfish: Florida has several.—C. H. K.

A TAXONOMIC AND DISTRIBUTIONAL STUDY OF SIMULIIDAE OF WESTERN UNITED STATES[1]

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Simuliidae, usually called black-flies or buffalo gnats, are abundant both as individuals and species in Utah and other western states.[3] The present report is an outgrowth of the study of blood-sucking flies and began at the time when equine encephalomyelitis was killing a large number of horses in Utah. It is known that certain diseases and parasites are transmitted through the feeding of female Simuliidae, and these frequently feed in large numbers on horses, other livestock, wild life and even annoy man. The species and distribution of these economically important pests are incompletely known in the west. Only material collected west of the Mississippi River is included, the bulk being taken from the Rocky Mountain area; most of this material is deposited in the Utah Agricultural Experiment Station insect collection.

This study is based on external and internal characters of adult specimens. The writers followed Dyar and Shannon in use of the stem-vein character (fig. 1), Edwards and Twinn in use of calcipala or projection on apex of hind basitarsi (fig. 2), and pedisulcus or dorsal incision on hind second basitarsi (fig. 2). The use of male terminalia for taxonomic characters was first used for this family in America by Pomroy, in 1916. The use of female genitalia is comparatively recent, first being used by Dyar and Shannon in 1927.

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[1]Contribution from the Department of Entomology, Utah Agricultural Experiment Station, Logan.

[2]Graduate research assistant and research associate professor, respectively.

[3]Available material consisted of several thousand mounted and many thousand unpinned traplight specimens collected in Utah. In addition the writers are indebted to the following entomologists and institutions that lent material for study: Dr. R. H. Beamer of the University of Kansas; E. S. Ross of the California Academy of Sciences; Dr. R. H. Painter of Kansas State College; Prof. H. C. Severin of the University of South Dakota; Prof. J. N. Knull of Ohio State University; Dr. M. T. James of Colorado State College; Dr. H. B. Mills of Montana State College; Dr. W. R. Salt of the University of Alberta; Dr. H. H. Ross of Illinois Natural History Survey; L. S. Lipovsky of State College of Washington; F. C. Harmston of Utah State Agricultural College. Special thanks are due Dr. A. Stone of the U. S. Bureau of Entomology and Plant Quarantine, for comparing western specimens with types in the National Museum, for rendering opinions on synonomy and for suggestions concerning the manuscript; to the U. S. National Museum for the loan of several species needed to complete this study; and to Dr. C. R. Twinn of the Canadian Division of Entomology, for the loan of comparison specimens and for suggestions.

TAXONOMY

KEY TO GENERA OF SIMULIIDAE

1. Radial sector simple, not forked (*E. osborni* has a weak fork); antennae always 11-segmented; radius may be setose its entire length or bare at base; calcipala and pedisulcus usually present.....2
   Radial sector with a long fork, antennae 9- to 11-segmented; radius always setose its entire length; calcipala and pedisulcus absent.....3
2. Radius setose its entire length; pedisulcus and calcipala present or absent, usually a large thumb-like projection at base of claws; fore tibiae without silver pilosity.....**Eusimulium**
   Radius plain, not setose its entire length; pedisulcus and calcipala always present; claws seldom with a thumb-like projection at base; usually a silver pilosity on fore tibia.....**Simulium**
3. Radius joining costa far beyond middle; antennae rarely 10-segmented, **Prosimulium**
   Radius joining costa in middle; antennae 10-segmented (rare)..**Parasimulium**

Genus **Parasimulium** Malloch

Parasimulium Malloch, U. S. Dept. Agr., Bur. Ent. Tech. Ser., No. 26, p. 24, 1914.

Only a single specimen is known for this genus and the monotypic species it contains. There has been a difference of opinion regarding the sex of this specimen. Malloch, in his original description, records it as a female; Knab considered it to be a male (Insec. Insc. Men., 2 : 150, 1914). Stone (Proc. Ent. Soc. Wash. 43 : 146–149, 1941) dissected out the internal genitalia, proving it to be a male.

Parasimulium furcatum Malloch

Parasimulium furcatum Malloch, U. S. Dept. Agr., Bur. Ent. Tech. Ser. No. 26, p. 25, 1914.

A small brownish species; frons broad; clypeus narrow; antennae yellow, 10-segmented; legs yellowish; calcipala and pedisulcus absent; pleurae yellowish; radial sector with a long wide fork; radius joining costa at its middle.

Type locality.—Humbolt County, California. Type in U. S. National Museum.

Genus **Prosimulium** Roubaud

(Figure 1)

Prosimulium Roubaud, Compt. Rend. Acad. Sci. Paris, 143: 519, 1906.

With few exceptions, species of this genus come from higher and colder altitudes. Medium to large species; claws usually simple, seldom possessing a thumb-like projection at base; antennae with 9 to usually 11 segments; pedisulcus and calcipala always absent; radial sector with a long branch; radius setose over its entire length; front and clypeus usually broad.

Genotype, *Simulium hirtipes* Fries.

KEY TO THE FEMALES OF PROSIMULIUM

1. Integument yellow.....2
   Integument black.....3
2. Claws with large thumb-like projection at base; frons narrow..**onychodactylum**
   Claws simple; frons broad.....**fulvum**

3. Claws with thumb-like projection at base.....**pleurale**
   Claws simple.....4
4. Antennae with 11 segments (basal segment sometimes hidden).....5
   Antennae with less than 11 segments (rare).....6
5. Antennae wholly yellow.....**flaviantennus**
   Antennae at most with basal two segments yellow.....7
6. Antennae 10-segmented.....**unicum**
   Antennae with 9 distinct segments.....**novum**
7. Stem vein dark pilose.....**dicum**
   Stem vein pale pilose.....8
8. Ovipositor flaps only moderately developed.....**exigens**
   Ovipositor flaps well developed (reaching tip of abdomen).....**dicentum**

KEY TO THE MALES OF PROSIMULIUM

1. Integument yellow; claspers bilobed with a single spine at apex of each lobe; adminiculum plain.....**fulvum**
   Integument black; claspers not bilobed; adminiculum modified.....2
2. Antennae wholly yellow; legs yellow, slightly infuscated apically..**flaviantennus**
   Antennae dark; legs fully infuscated or black.....3
3. Adminiculum narrow; side piece greatly modified (fig. 4).....**pancerastes**
   Adminiculum broad with conspicuous central keel; side piece plain...**exigens**

Prosimulium onychodactylum Dyar and Shannon

Prosimulium onychodactylum Dyar and Shannon, Proc. U. S. National Museum, 69: 4, 1927.

No specimens examined; characters taken from the original description. Integument brownish yellow; legs and antennae yellow; front narrow; claws with large thumb-like projection at base. Male unknown.

Type locality.—Long's Peak, Colorado. Type in U. S. National Museum.

Prosimulium novum Dyar and Shannon

(Figures 9, 10)

Prosimulium novum Dyar and Shannon, Proc. U. S. National Museum, 69: 5-6, 1927.

Medium sized, dark species; legs, antennae, integument, black. Distinguished from all other species of the genus by its distinct 9-segmented antennae; genitalia, figures 9–10. Male unknown. Paratype studied.

Type locality.—Two Medicine Lake, Montana. Type in U. S. National Museum.

Distribution.—Dyar and Shannon record it from Montana, Idaho, California, Washington.

Prosimulium fulvum Coquillett

(Figures 17, 18)

Prosimulium fulvum Coquillett, Proc. U. S. National Museum, 25: 96, 1903.

The bright yellow color serves to distinguish both sexes of this from all others of the genus with the possible exception of *onychodactylum*. It can be readily separated from this latter species by its simple claws; broad front. Genitalia of female, figures 17–18. Female rather common; one male has been found.

Type locality.—Bear Paw Mountain, Montana. Type in U. S. National Museum.

Distribution.—Mt. Baker, Washington, July 29, 1931 (R. H. Beamer); Mt. Hood, Oregon, July 1, 1927 (E. C. Van Dyke); Strawberry Camp, Grant Co., Oregon (H. A. Scullen); Crater Lake, 7100 ft., Oregon, July 29, 1930; Grand Teton Mountains, Wyoming, September 2, 1941 (J. S. Stanford). Dyar and Shannon also record it from Colorado and Idaho; Twinn from Utah.

Prosimulium unicum Twinn

Prosimulium unicum Twinn, Can. Ent., 70: 49, 1938.

No specimens at hand; known only by a single female. Characters from the original description would serve to differentiate it: antennae 10-segmented, long and slender; claws simple; body characters and color characters as in *hirtipes*. Male unknown.

Type locality.—Morgan, Utah. Type in Canadian National Museum.

Prosimulium flaviantennus (Stains and Knowlton)

(Figures 7, 11, 130, 131)

Eusimulium flaviantennus Stains and Knowlton, Ann. Ent. Soc. Amer., 33: 79, 1940.

Female with antennae 11-segmented, wholly yellow; thoracic integument black; scutum covered with dense yellow pile; legs yellow, infuscated apically; all coxae wholly black; claws simple. Genitalia, figures 7, 11. Male readily distinguished by its bright yellow antennae and legs, and distinct terminalia (figs. 130–131); otherwise as in *exigens*.

Male of this species heretofore unknown. Because of its close ecological association and close similarity of structure, the writers consider it to be the male of *flaviantennus*.

Type locality.—Logan Canyon, Utah. Type in U. S. National Museum.

Distribution.—Fort Collins, Colorado, July 5, 1938 (M. T. James); Kanosh Canyon, Utah, May 27, 1939 (Knowlton and F. C. Harmston); Leeds, Utah, June 21, 1941 (Knowlton and F. C. Harmston).

Prosimulium dicum Dyar and Shannon

(Figures 14, 15)

Prosimulium dicum Dyar and Shannon, Proc. U. S. National Museum, 69: 74, 1927.

Medium sized species; antennae 11-segmented, wholly black; legs black; claws simple; ovipositor flaps well developed; stem vein dark pilose, a character which separates this species from all others of the group. Genitalia, figures 14–15. Male unknown.

Type locality.—Hoodsport, Washington.

Prosimulium exigens Dyar and Shannon

(Figures 5, 6, 8, 12, 13)

Prosimulium exigens Dyar and Shannon, Proc. U. S. National Museum, 69: 10, 1927.
Eusimulium hardyi Stains and Knowlton, Ann. Ent. Soc. Amer., 33: 77–80, 1940.

Difficult to distinguish from the female of the eastern species *hirtipes*. Antennae 11-segmented, black, or with the basal two segments yellow; legs yellow, infuscated apically; ovipositor flaps moderately developed. Male readily distinguished by its broad adminiculum (fig. 6) with a conspicuous central transverse keel; clasper (fig. 5) short with three irregularly placed spines at apex.

Type locality.—Moscow, Idaho. Type in U. S. National Museum.

Distribution.—Idaho; Mt. Baker, Washington, July 29, 1931 (R. H. Beamer); Mill Creek Canyon, Utah, July 24, 1938 (Knowlton and D. E. Hardy;) Kanosh Canyon, Utah, May 27, 1939 (Knowlton and F. C. Harmston); Dyar and Shannon record it from Colorado.

Prosimulium pancerastes Dyar and Shannon

(Figures 3, 4)

Prosimulium pancerastes Dyar and Shannon, Proc. U. S. National Museum, 69: 10–11, 1927.

Rather large species; adminiculum (fig. 3) narrow, divided on narrow base; clasper short and narrow with 3 spines at apex; side piece greatly modified (fig. 4).

There is some question on the female specimens which Dyar and Shannon associated with the male. They stated, "It is not certain, therefore, that this is the true female of *pancerastes*."

Type locality.—Peck, Idaho. Type in U. S. National Museum.

Distribution.—Pullman, Washington, April 10, 1898 (C. V. Piper).

Prosimulium dicentum Dyar and Shannon

(Figures 16, 24)

Prosimulium dicentum Dyar and Shannon, Proc. U. S. National Museum, 69: 7, 1927.

A medium sized species close to *dicum*. Differs in having stem vein pale pilose; anal lobe (fig. 16) more rounded at base. Hearle, (Proc. Ent. Soc. B. C. 29: 7–8, 1932) first described the male from reared material.

Type locality.—Truckee, California. Type in U. S. National Museum.

Distribution.—Pullman, Washington; Smithfield Canyon, Utah, July 9, 1940 (Harmston and Stains); Scapoose, Oregon, May 21, 1937 (K. Gray and J. Schuh).

Prosimulium pleurale Malloch

(Figures 25, 26)

Prosimulium pleurale Malloch, U. S. Dept. Agr., Bur. Ent., Tech. Ser. No. 26: 17, 1914.

A species easily distinguished by its dark integument; claws with large thumb-like projection at base and tuft of pile on the anterior sternopleura, lower pteropleura, and upper anterior pteropleura. Genitalia as in figures 25, 26. Male unknown.

Type locality.—Kaslo, British Columbia. Type in U. S. National Museum.

Distribution.—Pullman, Washington, April 7, 1897 (R. W. Doane).

Genus **Eusimulium** Roubaud

Eusimulium Roubaud, Compt. Rend. Acad. Sci. Paris, 143: 519, 1906.

The species belonging to this genus have the radius setose over its entire length, radial sector simple, not forked as in *Prosimulium* (exception *osborni*). Calcipala and pedisulcus usually present; claws usually with a large thumb-like projection at base.

Genotype: *Simulium aureum* Fries.

KEY TO THE FEMALES OF EUSIMULIUM

1. Radial sector with a small branch ..... **osborni**
   Radial sector simple 2
2. Claws without thumb-like projection at base; calcipala large ..... **permutatum**
   Claws with a large thumb-like projection at base; calcipala small or absent .. 3
3. Mesopleura with a distinct tuft of pile (directly behind prothoracic spiracle) **borealis**
   Mesopleura bare 4
4. Postnotum with pile on apical margin; scutum and abdomen covered with dense pale pile; two basal segments of antennae yellow ..... **aureum**
   Postnotum lacking pile; pile on scutum and abdomen sparse; basal two segments of antennae rarely yellow 5
5. Pedisulcus deep and distinct; calcipala small; stem vein pale pilose .... **clarum**
   Pedisulcus shallow or absent; calcipala minute 6
6. Pile of stem vein black 7
   Pile of stem vein pale 8
7. Frons triangular, extremely narrow at base; large species, 3 mm. long (Texas) ..... **pecuarum**
   Frons of about equal width; size small, 2 mm. long ..... **minus**
8. Genital fork arms without ventral tooth, orifice between arms nearly a true circle ..... **johannseni**
   Genital fork arms with a distinct ventral tooth 9
9. Genital fork arms short and broad, with a large ventral tooth ..... **canonicolum**
   Genital fork arms long and slender, with two closely-set small ventral teeth **dacotense**

KEY TO THE MALES OF EUSIMULIUM

1. Postnotum with small patch of brassy pile on apical margin; adminiculum narrow, contracted and Y-shaped ..... **aureum**
   Postnotum without pile; adminiculum broad and membranous 2
2. Mesopleura with distinct patch of hair (directly behind prothoracic spiracle); hind basitarsus greatly flattened, wider than tibia ..... **borealis**
   Mesopleura without tuft of hair; hind basitarsus not wider than tibia 3
3. Clasper with 3 spines at apex; adminiculum broad and triangular ..... **obtusum**
   Clasper with 1 spine at apex; adminiculum not triangular 4
4. Adminiculum arcuate on dorsum; adminiculum arms with several small teeth 5
   Adminiculum truncate or with a depression on dorsum; single tooth or teeth of adminiculum arms large 6
5. Adminiculum as wide as long, nearly a true semicircle; clasper tapering to a point at apex ..... **dacotense**
   Adminiculum nearly twice as wide as long; clasper obliquely truncate at apex ..... **clarum**
6. Adminiculum truncate on dorsum, prongs long divergent (fig. 22); adminiculum arms with 4 or 5 large teeth ..... **johannseni**
   Adminiculum with a shallow depression on dorsum; adminiculum arms with only a single large tooth 7
7. Adminiculum with small nipple on dorsum; clasper plain ..... **pugetense**
   Adminiculum broad, quadrate, without any nipple; clasper with an inner notch at apex ..... **quadratus**

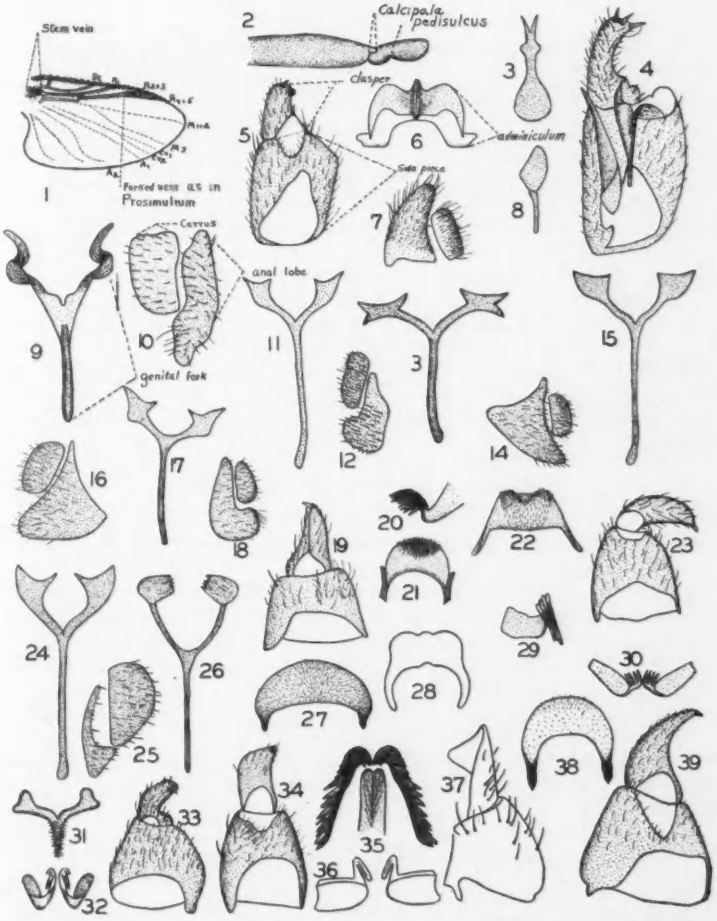


Figure 1, diagrammatic wing (*Prosimulium*); 2, first and second segments of hind tarsus (*Simulium*); 3–4, *P. pancerastes*, ♂ genitalia; 5–6, *P. exigens*, ♂ genitalia; 7, *P. flaviantennatus*, ♀ genitalia; 8, *P. exigens*, ♂; 9–10, *P. novum*, ♀ genitalia; 11, *P. flaviantennatus*, ♀ genitalia; 12–13, *P. exigens*, ♀ genitalia; 14–15, *P. dicum*, ♀ genitalia; 16, *P. dicentum*, ♀ genitalia; 17–18, *P. fulvum*, ♀ genitalia; 19–21, *Eusimulium borealis*, ♂ genitalia; 22–23, *E. johannseni*, ♂ genitalia; 24, *P. dicentum*, ♀ genitalia; 25–26, *P. pleurale*, ♀ genitalia; 27, *E. clarum*, ♂ genitalia; 28, *E. pugetense*, ♂ genitalia; 29, *E. johannseni*, ♂ genitalia; 30, *E. dacotense*, ♂ genitalia; 31–33, *E. aureum*, ♂ genitalia; 34–35, *E. clarum*, ♂ genitalia; 36–37, *E. pugetense*, ♂ genitalia; 38–39, *E. dacotense*, ♂ genitalia.

Eusimulium aureum (Fries)

(Figures 31, 32, 33, 60, 61)

Simulia aurus Fries, Monograph Simul. Suec., p. 16, 1824.
Simulium bracteatum Coquillett, U. S. D. A., Bur. Ent., Tech. Ser. No. 26, 1914.
Eusimulium pilosum Knowlton and Rowe, Ann. Ent. Soc. Amer., 27: 580–81, 1934.
Eusimulium utahense Knowlton and Rowe, Ann. Ent. Soc. Amer., 27: 582, 1934.

Both sexes can be distinguished from all others of the genus by the presence of brassy pile on postnotum (postscutellum). Female with bicolored legs; basal 2 segments of antennae yellow; scutum and abdomen covered with dense pale pile. Male wholly black or dark brown; scutum covered with long yellow pile. Genitalia of female, figures 60–61; of male, 31–33.

Type locality.—Unknown. Location of type unknown.

Distribution.—Logan, Millville, (K.-S.); Kingston, Leeds, Monarch, Soldier Summit (K.-Harmston); Brigham (K.-W.P. Nye); Spanish Fork (D. E. Hardy), in Utah. Boulder, May 18, 1932 (M. T. James), and Rabbit Ear Pass, August 19, 1940 (K.-Nye) in Colorado; Evanston, Wyoming, August 15, 1939 (K.-Harmston); Hood River (Childs) and Antelope Mt., Oregon, June 30, 1931, 6500 ft. (D. K. Frewig); Idaho and California.

Eusimulium clarum Dyar and Shannon

(Figures 27, 34, 35, 55, 56)

Eusimulium clarum Dyar and Shannon, Proc. U. S. National Museum, 69: 21–22, 1927.

Female dark; pedisulcus deep and distinct; calcipala distinct; stem vein pale pilose; genital fork arm plates broad with a distinct large ventral tooth (fig. 56). Male, clasper short, obliquely truncate (fig. 34), with terminal spine; adminiculum broad, arcuate, considerably longer than wide (fig. 27).

Type locality.—Fresno, California. Type in U. S. National Museum.

Distribution.—Oroville, California, March 13, 1938 (H. H. Deifer). Nixon, Nevada, June 29, 1927 (E. P. Van Duzee). Logan, Utah, July 22, 1938 (K.-Hardy). Dyar and Shannon also list Montana. Paratype male examined.

Eusimulium minus Dyar and Shannon

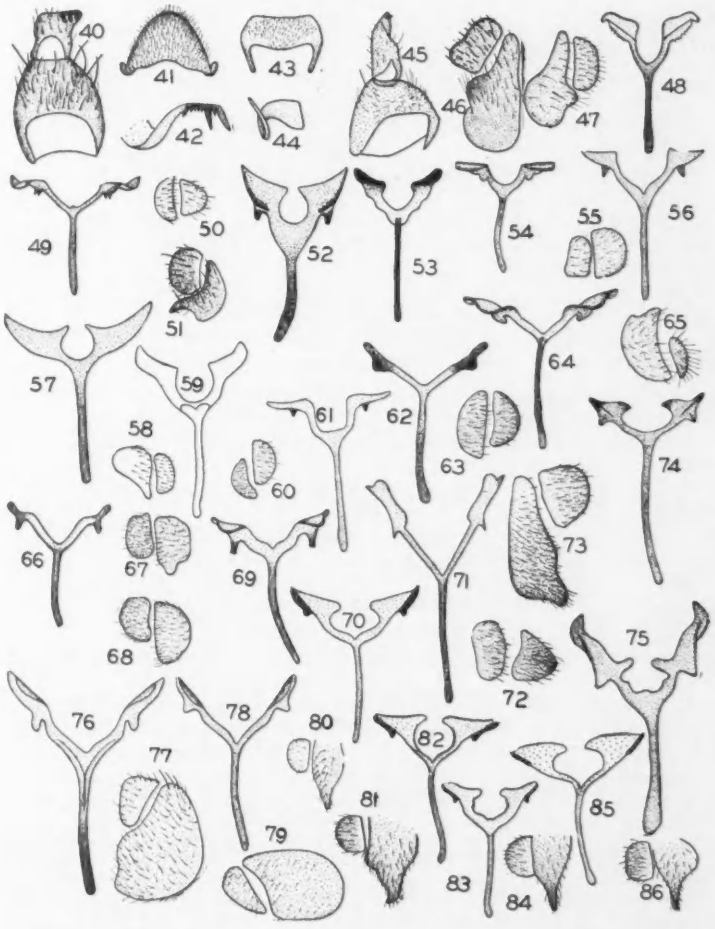
(Figure 54)

Eusimulium minus Dyar and Shannon, Proc. U. S. National Museum, 69: 21, 1927.

Close to *canonicolum* and *dacotense*; differs in possessing dark pile on stem vein; genital fork arm plates with a small ventral tooth (fig. 54). Hearle (Proc. Ent. Soc. British Col. 29 : 10, 1932) first described the male from reared material.

Type locality.—Yosemite, California. Type in U. S. National Museum.

Distribution.—Dyar and Shannon record it from Idaho, Montana, Washington, and Wyoming; paratype examined.



Figures 40–45, genitalia of ♂; 46–86, genitalia of ♀. Figures 40–42, *Eusimulium obtusum;* 43–45, *E. quadratus;* 46, *E. pecuarum;* 47–48, *E. mutatum permutatum;* 49–50, *E. dacotense;* 51–52, *E. canonicolum;* 53, *E. pecuarum;* 54, *E. minus;* 55–56, *E. clarum;* 57, *E. johannseni;* 58–59, *E. borealis;* 60–61, *E. aureum;* 62–63, *Simulium venustum;* 64–65, *S. hunteri;* 66–67, *S. occidentale;* 68–69, *S. sayi;* 70, *S. beameri;* 71–72, *S. canadense;* 73–74, *S. vittatum;* 75, *S. virgatum;* 76–77, *S. decorum;* 78–79, *S. arcticum;* 80, *S. beameri;* 81–82, *S. bivittatum;* 83–84, *S. griseum;* 85–86, *S. meduvittatum.*

Eusimulium mutatum permutatum Dyar and Shannon

(Figures 47, 48)

Eusimulium mutatum permutatum Dyar and Shannon, Proc. U. S. National Museum, 69: 17–18, 1927.

Readily distinguished by its simple claws; strong calcipala; absence of pedisulcus; dark color of antennae, legs and body. Plates of genital fork large, broad, serrate on ventral surface (fig. 48). Male unknown.

Type locality.—Prince Rupert, British Columbia. Type in U. S. National Museum.

Distribution.—Mt. Baker, Washington, July 29, 1931 (R. H. Beamer). Recorded from Montana, Idaho, Wyoming and California by Dyar and Shannon.

Eusimulium borealis (Malloch)

(Figures 19, 20, 21, 58, 59)

Prosimulium borealis Malloch, Rept. Can. Arctic Exp., 3: 418, 1918.

Distinguished from all others by a tuft of hair on the mesopleural membrane in both sexes. Body grayish black; pedisulcus absent; calcipala small; genitalia of female (after Twinn) figures 58–59; of male, figures 19–21.

Type locality.—Woolston Peninsula, Victoria Island. Type in Canadian National Collection.

Distribution.—Tooele, Utah, July 7, 1938 (Knowlton-F. C. Harmston). Dyar and Shannon also record it from Montana.

Eusimulium dacotense Dyar and Shannon

(Figures 30, 38, 39, 49, 50)

Eusimulium dacotense Dyar and Shannon, Proc. U. S. National Museum, 69: 20–21, 1927.

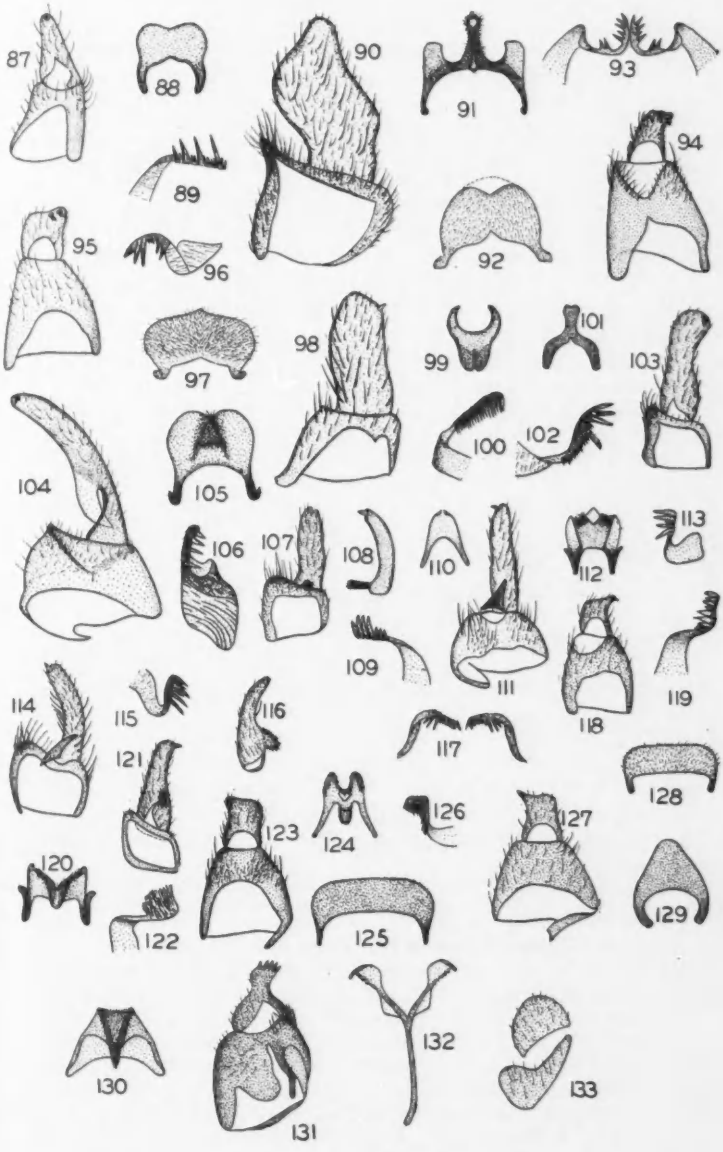
Female small, dark; pedisulcus shallow; calcipala minute; stem vein pale pilose; antennae wholly black; scutum with sparse pale yellow pile. Genitalia, figures 49–50. Male large, dark; pedisulcus and calcipala absent. Readily separated from all other males of the genus by its nearly semicircular adminiculum (fig. 38) and pointed clasper (fig. 39).

Type locality.—Brookings, South Dakota. Type in U. S. National Museum.

Distribution.—Mink Creek, Idaho, June 25, 1939 (Knowlton); paratype from South Dakota examined.

EXPLANATION OF PLATE III

Figures 87–131, genitalia of ♂; 132–133, genitalia of ♀. Figures 87–89, *Simulium occidentale;* 90–91, *S. virgatum;* 92–94, *S. vittatum;* 95–97, *S. kamloopsi;* 98–100, *S. venustum;* 101–103, *S. arcticum;* 104–106, *S. canadense;* 107–110, *S. jacumbae;* 111–113, *S. knowltoni;* 114–115, *S. stonei;* 116, *S. vandalicum;* 117, *S. mediovittatum;* 118–119, *S. griseum;* 120, *S. stonei;* 121, *S. vandalicum;* 122–123, *S. bivittatum;* 124, *S. vandalicum;* 125, *S. bivittatum;* 126, *S. vandalicum;* 127, *S. mediovittatum;* 128, *S. griseum;* 129, *S. mediovittatum;* 130–131, *Prosimulium flaviantennatus;* 132–133, *Eusimulium osborni.*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Eusimulium canonicolum Dyar and Shannon

(Figures 51, 52)

Eusimulium canonicolum Dyar and Shannon, Proc. U. S. Nat. Mus., 69: 22, 1927.

A small dark species; antennae wholly black; claws with large thumb-like projection at base; stem vein pale pilose; genital fork (fig. 52) with broad thick arms and a distinct large ventral tooth. Male unknown.

Type locality.—Yellowstone Canyon, Wyoming. Type in U. S. National Museum.

Distribution.—Dyar and Shannon record it from California, Colorado, Idaho and Wyoming.

Eusimulium pecuarum (Riley)

(Figures 46, 53)

Simulium pecuarum Riley, Rept. U. S. Dept. Agr. 1886, p. 512.

Large dark species about 3 mm. long; antennae black, basal 2 segments brown; frons triangular, extremely narrow at base; claws with large thumb-like projection at base; scutum with 3 indistinct stripes when viewed from front; calcipala small; pedisulcus absent; legs brownish. Genitalia, figures 46, 53. The male was redescribed and figured by Bradley (Proc. Ent. Soc. Wash. 37 : 63–64, 1935).

Type locality.—Somerset Landing, Louisiana. Type in U. S. National Museum.

Distribution.—Lufkin, Texas, January 17, 1941 (H. J. Reinhard).

Eusimulium johannseni (Hart)

(Figures 22, 23, 29, 57)

Simulium johannseni Hart, 27th Ill. St. Ent. Rept., p. 32, 1912.

Female with stem vein pale pilose; calcipala minute; pedisulcus shallow; antennae black; scutum with three indistinct vittae, clothed with pale pile; genital fork arms horn-like without ventral tooth; genitalia, figure 57. Male with integument and antennae black; legs paler in color; scutum with sparse pale pile; adminiculum truncate, with a small triangular notch on dorsum (fig. 22), prongs divergent; adminiculum arms with four or five large teeth (fig. 29).

Type locality.—Havana, Illinois. Type in Illinois Natural History Survey collection.

Distribution.—Dyar and Shannon also list Idaho. Paratypes examined.

Eusimulium obtusum Dyar and Shannon

(Figures 40, 41, 42)

Eusimulium obtusum Dyar and Shannon, U. S. National Museum Proc., 69: 15, 1927.

One cotype male at hand is mounted on a slide in balsam with only the terminalia in good condition. Side piece a little longer than broad; clasper short (fig. 40), truncate with 3 terminal spines at apex; adminiculum broad and triangular (fig. 41); adminiculum arms each with 2 large teeth (fig. 42). Female unknown.

Type locality.—Redlands, California. Type in U. S. National Museum.

Eusimulium pugetense Dyar and Shannon

(Figures 28, 36, 37)

Eusimulium pugetense Dyar and Shannon, Proc. U. S. National Museum, 69: 23, 1927.

Eusimulium quebecense Twinn, Can. Journ. Res., 14: 117-118, 1936.

The following description (except figure numbers) is from Twinn's *quebecense*, a synonym of *pugetense*. Female near *aureum*, differs in having antennae entirely black; postnotum devoid of brassy pile, pilosity more sparse. Male characterized by yellow pilosity on scutum; integument, antennae, pubescence, halteres, stem vein and plural tuft black; adminiculum with small nipple in a median depression on the dorsum (fig. 28); adminiculum arms with a single large tooth (fig. 36). Genitalia figures are redrawn from Twinn.

Type locality.—Seattle, Washington. Type male in U. S. National Museum.

Eusimulium quadratus n. sp.

(Figures 43, 44, 45)

Male.—Length 1.9 mm.; wing 2.3 mm. With characters of the genus. Radius setose its entire length, radial sector simple. Head black; clypeus pale yellow pilose. Antennae 11-segmented, black. Thorax black; scutum velvety black, covered with sparse pale yellow pile; scutellum with long pale pile; pleurites dark. Legs brownish black, covered with sparse pale yellow pile; hind basitarsus about the same width as the tibia; pedisulcus and calcipala present. Halteres light brown; stem vein pale pilose. Abdomen black, covered with sparse pale pile, basal fringe pale. Genitalia: adminiculum (fig. 43) broad and quadrate; clasper (fig. 45) with an inner notch at apex and a single spine; adminiculum arms (fig. 44) with a single large tooth.

Taxonomy.—*Eusimulium quadratus* is near *pugetense* but differs in having a broader adminiculum and not possessing a nipple on dorsum. This may prove to be the undescribed male of *canonicolum*.

Holotype.—Male. Logan Canyon, Utah, June 28, 1940 (Knowlton). *Paratype*: Male. Same data as holotype.

Eusimulium osborni n. sp.

(Figures 132, 133)

Female.—Length 2.2 mm., of wing 2.5 mm. Head black; clypeus grayish pruinose, frons grayish pruinose, narrow at base. Antennae wholly black with the second segment enlarged. Thorax black; scutum black, covered with sparse pale pile; scutellum dark and bare. Legs black; pedisulcus present, calcipala shallow; claws with large thumb-like projection. Wings dark; stem vein dark pilose; radial sector with a short fork; halteres dark brown. Genitalia as in figures 132 and 133.

Taxonomy.—*E. osborni* differs from all other *Eusimulium* with the exception of *lascivum* Twinn in having a small branch on the radial sector. It differs from *lascivum* Twinn in possessing a large thumb-like projection at base of claws and in genitalia characters.

Holotype.—Female, Brightman Flat, Tuolune County, California, June, 1941 (R. T. Orr), on grouse. *Paratypes*.—Females with same data.

Genus **Simulium** Latreille

(Figure 2)

Simulium Latreille, Hist. Nat. Ins. et. Crust., 3: 426, 1802.

Radial sector simple, bare from the stem vein to the base of the radial sector; calcipala and pedisulcus always present; usually silvery pilosity on fore tibia; claws seldon possessing a large thumb-like projection at base; small basal tooth present or absent.

Genotype: *Culex reptans* Linnaeus.

KEY TO THE FEMALES OF SIMULIUM

1. Legs wholly black; claws with large thumb-like projection at base. . **occidentale**
   Legs bicolored; claws without large thumb-like projection at base (may have small basal tooth) 2
2. Fore coxae yellow; frons shining black or grayish pruinose 3
   Fore coxae black; frons always grayish pruinose 4
3. Claws with small basal tooth[4] 5
   Claws simple, without such a tooth 6
4. Claws plain, without small basal tooth; five dark vittae on scutum; genital fork arms ending in large quadrangular plates . . . . . **vittatum**
   Claws with small basal tooth; scutum with 3 indistinct vittae; genital fork arms ending in small plates with a distinct ventral tooth . . . . . **sayi**
5. Frons grayish pruinose; stem vein always dark pilose 7
   Frons shining black; stem vein pale pilose or dark pilose 8
6. Antennae black, with only 2 basal segments yellow; fore tarsal segments largely flattened; anal lobe rounded, not produced ventrally 9
   Antennae wholly yellow or infuscated toward apex; fore tarsal segments not flattened; anal lobe produced to a point ventrally 10
7. Antennae brown with 2 basal segments yellow; scutum with an orange tinge; species 2.5 mm. long; genitalia fig. 75 . . . . . **virgatum**
   Antennae black with two basal segments brown; scutum wholly black; species about 2 mm. long; genitalia figs. 71–72 . . . . . **canadense**
8. Mesonotum with 3 narrow pollinose vittae; pile of stem vein dark; anal lobe small and narrow . . . . . **hunteri**
   Mesonotum without vittae, only 2 silvery pruinose areas at front of scutum; pile of stem vein pale; anal lobe large and broad . . . . . **arcticum**
9. Frons grayish pruinose; anal lobe at least 3 times larger than cercus. . **decorum**
   Frons shining black; anal lobe only slightly larger than cercus. . . . . **venustum**
10. Scutum with a single distinct central stripe or with 2 silvery white stripes. . . 11
    Scutum plain, without distinct stripes 12
11. Scutum with 2 broad silvery white stripes . . . . . **bivittatum**
    Scutum with a single distinct central stripe 13
12. Antennae wholly yellow; legs yellow except fore tarsi and apical segment of middle and hind tarsi (rare) . . . . . **notatum**
    Antennae infuscated apically; legs yellow except apex of first and second, third, fourth and fifth segments of middle and hind tarsi; fore tarsi black . . . . . **griseum**
13. Scutum yellow with a central dark brown strip; antennae wholly yellow, **mediovittatum**
    Scutum opaque black, with a distinct central velvety black stripe; antennae infuscated apically . . . . . **beameri**

KEY TO THE MALES OF THE GENUS SIMULIUM

1. Clasper at least one-fourth longer than side piece; adminiculum contracted, solid 2
   Clasper shorter than or as long as side piece; adminiculum broad and membranous 3

[4]The small basal tooth usually can be seen only under high magnification. To see this character, place the claw on a slide in a small amount of glycerine; place a small cover glass over glycerine and press until full side view of claw is visible.

2. Clasper with an inner lateral projection at base (plainly seen when clasper is turned on side); small species, usually less than 2 mm. long....4
   Clasper plain, without such projection; species usually more than 2 mm. long....5
3. Clasper truncate at apex, about half as long as side piece; legs bicolored....6
   Clasper tapering to a point at apex, about as long as side piece; legs wholly black....**occidentale**
4. Lateral projection at base of clasper sharply pointed; prongs of adminiculum with lateral projections....7
   Lateral projection at base of clasper rounded, spinose or long and serrated on apex; prongs of adminiculum plain, without lateral projections....8
   Ribbon-like structure lying parallel to clasper (fig. 104), adminiculum arcuate, with small notch on dorsum....**canadense**
5. Clasper greatly flattened and irregularly curved, about twice as long as wide; adminiculum with shoulders projecting (fig. 91)....**virgatum**
   Clasper not so flattened nor irregularly curved, approximately 3 times as long as wide; adminiculum without definite shoulders....9
6. Clasper with a single terminal spine at apex or none; middle femora and tibia wholly yellow or only slightly infuscated....10
   Clasper with 2 or more spines at apex; middle femora and tibia at least one-half black....11
7. Adminiculum with a central cone on dorsum extending well above shoulders, **knowltoni**
   Adminiculum with a trough-like incision on dorsum....**stonei**
8. Projection at base of clasper narrow, fully twice as long as wide, serrated only on apex, adminiculum narrow, conical on dorsum (fig. 110)..**jacumbae**
   Projection at base of clasper round, spinose, about as long as wide; adminiculum with deep dorsal incision and ventral keel (fig. 124), **vandalicum**
9. Adminiculum Y-shaped, base narrow; adminiculum arms with large teeth (fig. 102)....**arcticum**
   Adminiculum somewhat tooth-shaped with a divided base or broad and arcuate; adminiculum arms with small teeth....12
10. Adminiculum rectangular, twice as wide as long, a little curved on dorsum...13
    Adminiculum narrow, triangular, about as wide as long....**mediovittatum**
11. Clasper truncate, with two spines at apex; scutum with 2 conspicuous silvery stripes extending half of its length....**kamloopsi**
    Clasper tapers toward apex, with 3 terminal spines; scutum with only 2 small indistinct anterior pollinose stripes on dorsum....**vittatum**
12. Adminiculum arcuate, with small notch on dorsum; clasper narrow, twice length of side piece....**canadense**
    Adminiculum narrow and tooth-shaped; clasper broad, about 1.5 length of side piece....**venustum**
13. Small species about 1.5 mm. long; scutum with a greenish metallic tinge; apex of clasper obliquely truncate....**griseum**
    Species about 2 mm. long; scutum velvety black, with 2 anterior pollinose patches; clasper truncate at apex....**bivittatum**

Simulium occidentale Townsend

(Figures 66, 67, 87, 88, 89)

Simulium occidentale Townsend, Psyche, 6: 107, 1891.

A medium sized dark species in both sexes. Females readily distinguished by presence of a large thumb-like projection at base of claws; legs and antennae wholly black or dark brown. Male with legs, antennae, integument and halteres wholly dark brown or black. Genitalia of female, figures 66–67; of male, figures 87–89.

Type locality.—Rio Grande Valley, New Mexico. Location of type unknown.

Distribution.—The writers have examined material of this species from Utah, Idaho, California, Kansas, South Dakota, New Mexico and Colorado; Dyar and Shannon also recorded it from Texas.

Simulium virgatum Coquillett

(Figures 75, 90, 91)

Simulium virgatum Coquillett, Proc. U. S. National Museum, 25: 87, 1903.

A rather large, light colored species in both sexes. Female with frons grayish pilose; antennae brown, basal two segments yellow; fore coxae yellow; claws with small basal tooth; mesonotum with two diagonal stripes, space between stripes brownish-orange; arms of genital fork with large spear-shaped endings (fig. 75). Male can be distinguished by its large, flattened and irregularly curved claspers (fig. 90).

Type locality.—Las Vegas, Hot Springs, New Mexico. Type in U. S. National Museum.

Distribution.—Nephi, Utah, June 16, and Mt. Timpanogos, Utah, August 17, 1941 (Knowlton-F. C. Harmston); Pine, Oregon, 7–22–92; Texas. Dyar and Shannon also record it from California, New Mexico, South Dakota.

Simulium vittatum Zetterstedt

(Figures 73, 74, 92, 93, 94)

Simulium vittatum Zetterstedt, Ins. Lappon. Dipt., 1835, p. 803.

Probably the most cosmopolitan species in the entire family. Females large, gray colored; legs bicolored, basal 2 antennal segments yellow, remainder dark; mesonotum with 5 dark stripes; claws simple; frons grayish pruinose; fore coxae black. Male rather variable, resembles several species externally; internal terminalia very characteristic. Female genitalia, figures 73–74; male, figures 92–94.

Type locality.—Probably Lapland. Type presumably in University of Lund, Sweden.

Distribution.—Material examined from Utah, Idaho, Colorado, Nevada, Wyoming, Washington, Oregon, Montana, Nebraska, Kansas, South Dakota, California and New Mexico.

Simulium kamloopsi Hearle

(Figures 95, 96, 97)

Simulium kamloopsi Hearle, Proc. Ent. Soc. B. C., No. 29, 12–13, 1932.
Simulium hearlei Twinn, Can. Ent., 70: 50, 1938.

A medium small, dark colored species with bicolored legs. Distinguished readily by two conspicuous silvery pollinose stripes on the dorsum of the mesonotum; fore tibiae with conspicuous silvery pilosity. Male genitalia as in figures 95–97. Female unknown.

Type locality.—Kamloops, B. C. Type in Canadian National Museum.

Distribution.—Ft. Duchesne, Midvale, Logan, Juab, Granite and Bluff in Utah; Buhl, and Arimo, Idaho, August, 1939 (Knowlton- F. C. Harmston).

Simulium venustum Say

(Figures 62, 63, 98, 99, 100)

Simulium venustum Say, Jour. Acad. Sci. Phila., 3: 28, 1829.

Female close to ***arcticum;*** differs in having stem vein usually dark pilose and no basal tooth on claws; genitalia figures 62–63. Male resembles a number of other species externally, but differs markedly in genitalia (figs. 98–100).

Type locality.—Shippingsport, Ohio. Location of type unknown.

Distribution.—Utah, Idaho, Colorado, California, Washington, Montana, Wyoming. Dyar and Shannon also record it from Texas.

Simulium decorum Walker

(Figures 76, 77)

Simulium decorum Walker, Cat. Brit. Mus. Dipt., Vol. 1, p. 112, 1848.

Female large; fore coxae yellow; frons shining black; antennae black, basal two segments yellow; stem vein pale pilose; claws simple. Genitalia, figures 76–77. No males at hand.

Type locality.—Martin Fall, Ontario. Type in British Museum.

Distribution.—Boulder, Colorado (T. D. A. Cockerell).

Simulium sayi Dyar and Shannon

(Figures 68, 69)

Simulium sayi Dyar and Shannon, U. S. National Museum Proc., 69: 40–41, 1927.

A large dark colored species about 3.2 mm. long; characterized by prominent yellow markings on hind basitarsi; frons grayish pruinose; fore coxae black; antennae black; pile on stem vein dark; claws with small basal tooth; scutum with three indistinct vittae; genitalia as in figures 68–69. Male unknown.

Type locality.—Virginia Dale, Colorado. Type in U. S. National Museum.

Distribution.—Logan Canyon, Utah, October 10, 1938 (F. C. Harmston). Roosevelt, Utah, July 7, 1940, and Moab, Utah, (Knowlton-Harmston); Spearfish, South Dakota, July 28, 1924, (Hull, Det. A. Stone); Colorado.

Simulium hunteri Malloch

(Figures 64, 65)

Simulium hunteri Malloch, U. S. Dept. Agr., Bur. Ent., Ser. 26: 59, 1914.

A rather large species distinguished by shining black frons; fore coxae yellow; distinct sharp basal tooth on claws; stem vein dark pilose; mesonotum with three narrow vittae; antennae black, basal two segments yellow. Genitalia as in figures 64–65. Male unknown.

Type locality.—Virginia Dale, Colorado. Type in U. S. National Museum.

Distribution.—Logan Canyon, Utah, October 10, 1938 (Harmston); Spearfish, South Dakota (Hull, Det. A. Stone); Estes Park, Colorado, August 8, 1925 (H. C. Severin, Det. Stone); Grand Teton Mountains, Wyoming, September 2, 1941 (J. S. Stanford). Dyar and Shannon also record it from New Mexico.

Simulium arcticum Malloch

(Figures 78, 79, 101, 102, 103)

Simulium arcticum Malloch, U. S. Dept. Agr., Bur. Ent. Tech. Ser. 26: 37, 1914.
Simulium brevicercum Knowlton and Rowe, Ann. Ent. Soc. Amer., 27: 583, 1934.
Simulium nigresceum Knowlton and Rowe, Ann. Ent. Soc. Amer., 27: 583, 1934.
Simulium corbis Twinn, Can. Jour. Res., 14: 147–148, 1936.

Female, medium to large; fore coxae yellow; frons shining black; antennae black, basal two segments yellow; scutum with two anterior silvery pollinose patches; stem vein pale pilose; claws with small basal teeth; genitalia, figures 78–79. Male readily distinguished by its long simple clasper (fig. 103) and inverted Y-shaped adminiculum (fig. 101).

Type locality.—Kaslo, British Columbia. Type in U. S. National Museum.

Distribution.—Material examined from California, Utah, Washington, Idaho, Colorado. Dyar and Shannon also list it from Montana, Nevada, Oregon and Wyoming.

Simulium canadense Hearle

(Figures 71, 104, 105, 106)

Simulium virgatum canadense Hearle, Proc. B. C. Ent. Soc., 29: 14–15, 1932.
Simulium fraternum Twinn, Can. Ent., 70: 53–54, 1938.

Female fairly large, dark colored, near *virgatum;* differs in being a little smaller in size; antennae black, basal two segments brown; genital fork arms (fig. 71) ending in small rectangular plates, with distinct ventral tooth and a small apical tooth. Male having long narrow clasper (fig. 104) with narrow ribbon-like projection pointed at base; adminiculum (fig. 105) arcuate, with a small central notch on dorsum.

Type locality.—Kamloops, British Columbia. Type in Canadian National Collection.

Distribution.—Farmington, Utah, April 9, 1934 (Knowlton-C. F. Smith).

Simulium jacumbae Dyar and Shannon

(Figures 107, 108, 109, 110)

Simulium jacumbae Dyar and Shannon, Proc. U. S. National Museum, 69: 44–45, 1927.

Small, about 1.9 mm. long; belongs with the group of species having the inner lateral projection at base of clasper (fig. 108). Readily distinguished from other members of the group by the narrow adminiculum, conical on dorsum (fig. 110).

Type locality.—Jacumba Springs, California. Type in U. S. National Museum.

Distribution.—Cowley, Colorado, September 2, 1939 (M. T. James); Little Lake, California, July 25, 1940 (D. E. Hardy); Santa Clara, Utah, July 19, 1941 (Harmston-Knowlton).

Simulium knowltoni Twinn

(Figures 111, 112, 113)

Simulium knowltoni Twinn, Can. Ent., 70: 53, 1938.

Small, about 2.2 mm. long; belongs in the group having a lateral projection on inner side at base of clasper; differing from all others except *stonei* in having this projection at base of clasper sharply pointed (fig. 111). Readily distinguished from *stonei* in possessing a central cone-like projection on dorsum of adminiculum (fig. 112). Female unknown. This may prove to be the undescribed male of *sayi* D.-S.

Type locality.—Logan, Utah. Type in Canadian National Museum.

Distribution.—Logan, Utah; Monticello, Utah, May 13, 1939 (Knowlton-F. C. Harmston); California (A. Stone).

Simulium stonei n. sp.

(Figures 114, 115, 120)

Male.—Length 1.9 mm.; wing 2.2 mm. With characters of the genus; radius bare, devoid of setae; radial sector simple. Head black; clypeus silvery pruinose; antennae wholly black and 11-segmented. Thorax black; scutum and scutellum black with sparse yellow pile; pleurites silvery pruinose. Legs black, sometimes infuscated. Wings darkened at base, stem vein black pilose; halteres pale yellow, base merging into black. Abdomen black; apical segments slightly silvery pruinose; basal fringe brown. Genitalia: adminiculum (fig. 120) with branched prongs, a trough-like incision on dorsum; adminiculum arms (fig. 115) with several large teeth; clasper (fig. 114) with a sharply pointed non-spinose projection at base. Female unknown.

Taxonomy.—*Simulium stonei* is near *knowltoni*. It differs distinctly in having a trough-like incision on dorsum of adminiculum (fig. 120).

Holotype.—Male, Logan, Utah, September 16, 1939 (Knowlton-Stains). *Paratypes.*—Males, Logan Canyon, Utah, October 3, 1937 (D. E. Hardy); Pocatello, Idaho, September 20, 1939 (Harmston).

Simulium vandalicum Dyar and Shannon

(Figures 116, 121, 124, 126)

Simulium vandalicum Dyar and Shannon, U. S. National Museum Proc., 69: 44, 1927.

Simulium turmale Twinn, Can. Ent., 70: 51, 1938.

Small dark species about 1.9 mm. long. Belongs in group with basal projection on clasper (fig. 116) rounded, about as long as wide and heavily spinose; adminiculum with a deep dorsal incision, ventral keel below incision (fig. 124); prongs of adminiculum divergent without any lateral projections. Dyar and Shannon state that the female is indistinguishable from *venustum*.

Type locality.—Fallen Leaf, California. Type in U. S. National Museum.

Taxonomy.—Upon the request of the writers, Dr. A. Stone compared the holotype of *S. twinni* S.-K. with *S. vandalicum* D.-S. He stated, "It does not seem possible to distinguish *Simulium twinni* from *S. vandalicum*, save that the terminalia of *twinni* are slightly smaller. I can see no significant differences. The dorsal incision is not quite so deep as in the holotype of *twinni*, but the difference is very slight." Because of the above information, the writers are tentatively considering *twinni* (Ann. Ent. Soc. Amer. 33: 77–80, 1940) a variety of *vandalicum*. Twinn records *turmale* Tw. from Utah; this appears to be a synonym of *vandalicum*.

Simulium bivittatum Malloch

(Figures 81, 82, 122, 123, 125)

Simulium bivittatum Malloch, U. S. Dept. Agr., Bur. Ent. Tech. Ser. 26: 31, 1914.
Simulium idahoense Twinn, Can. Ent., 70: 50–51, 1938.

Female small, pale colored, about 1.7 mm. long; can readily be separated from other species by two broad silvery pollinose stripes on the mesonotum; antennae infuscated. Genitalia, figures 81–82. Male closely resembles *mediovittatum* externally; differs internally in having adminiculum twice as wide as long (fig. 125) and only slightly arcuate on dorsum.

Type locality.—East Las Vegas, New Mexico. Type in U. S. National Museum.

Distribution.—Also includes Utah, Idaho, Colorado, South Dakota.

Taxonomy.—Heretofore, the male of *bivittatum* has been unknown. The type locality and data of *idahoense* are the same as for a long series of *bivittatum* females at hand; also on three different occasions males of *idahoense* and females of *bivittatum* have been taken together. Twinn, in his original description, suggested his species might be the male to *bivittatum*. The writers consider this to be the case.

Simulium notatum Adams

Simulium notatum Adams, Kan. University Sci. Bul., 2: 434, 1904.

A small pale yellow species close to *griseum;* female distinguished from *griseum* by legs being entirely yellow except fore tarsi and apical segments of middle and hind tarsi; antennae wholly yellow.

Type locality.—Williams Fork, Arizona. Type in University of Kansas insect collection.

Distribution.—Dyar and Shannon record it from New Mexico, Texas. Cotype female examined.

Simulium griseum Coquillett

(Figures 83, 84, 118, 119, 128)

Simulium griseum Coquillett, U. S. Dept. Agr. Bul. 10, n. ser., p. 69, 1898.

Female pale colored, about 1.7 mm. long; legs largely yellow; antennae infuscated apically; mesonotum plain or with faintly distinguishable median stripe. Genitalia, figures 83–84. Male with metallic greenish mesonotum, sometimes a rather distinct median stripe. Genitalia, figures 118–119, 128.

Type locality.—Colorado. Type in U. S. National Museum.

Distribution.—Ft. Collins, Colorado, June 16, 1905; Musselshell, Montana, July 11, 1917; Strawberry Valley, Utah, June 14, 1940 (Knowlton); Manila, Utah, September 5, 1939 (K.-Harmston); Cascade Springs, South Dakota, July 30, 1935 (H. C. Severin). Dyar and Shannon also record it from New Mexico.

Simulium mediovittatum Knab

(Figures 85, 86, 117, 127, 129)

Simulium mediovittatum Knab, Ins. Mens., 3: 77, 1916.
Simulium venator Dyar and Shannon, U. S. National Museum Proc., 69: 36, 1927.

Female mesonotum yellow pollinose with a distinct brown median stripe; antennae wholly yellow; fore tarsi largely black; remainder of legs mostly yellow. Genitalia, figures 85–86. Male with a wide median yellow stripe on posterior part of mesonotum or with scutum mostly black; antennae infuscated; adminiculum about as long as wide, conical on dorsum (figs. 117, 127, 129).

Type locality.—Arlington, Texas. Type in U. S. National Museum.

Distribution.—Lewiston, Utah, on nose of horse suffering from equine encephalomyelitis (J. A. Rowe); Riverdale, Idaho, August 22, 1934 (Knowlton-C. F. Smith); Weiser, Idaho; Meacham and Dixie, Oregon, September 2, 1940 (F. C. Harmston); 10 miles east of Huntington, Oregon, July 22, 1936 (H. A. Scullen). Dyar and Shannon record it also from Nevada, California and Montana.

Simulium trivittatum Malloch

Simulium trivittatum Malloch, U. S. Dept. Agr., Bur. Ent., Tech Ser. 26: 30, 1914.

No specimens examined; female close to ***bivittatum***. Separated from this species by three dark brown vittae on scutum; genitalia characters showing distinct differences (Dyar and Shannon, Proc. U. S. National Museum 69, 1927, plate 6, fig. 78). Recorded from Texas by Dyar and Shannon.

Simulium beameri n. sp.

(Figures 70, 80)

Female.—Length 1.3 mm.; wing 1.6 mm. Head black; clypeus grayish pruinose; frons grayish pruinose with a black ground color. Antennae yellow, apical two-thirds infuscated. Thorax black; scutum black, edges merging into yellow, a black velvety stripe extending down its middle, scutellum yellow, pleurites mostly black. Legs bicolored. Wings with all veins pale yellow, stem vein pale pilose; halteres pale yellow. Abdomen yellowish with the usual black dots on dorsum. Genitalia as in figures 70 and 80.

Male.—Length 1.3 mm.; wing 1.7 mm. Head black; antennae yellow, infuscated apically; clypeus grayish pruinose. Thorax velvety black; two small grayish pruinose patches on fore part and lateral and apical edges of scutum; scutellum black; pleurites grayish pruinose. Wings with stem vein pale pilose; halteres yellow. Abdomen black; apical segments of abdomen with grayish pruinose areas.

Genitalia indistinguishable from those of ***mediovittatum*** (cf. figures 117, 127, 129).

Taxonomy.—*S. beameri* is near ***mediovittatum*** but differs in having a dark to black scutum with a velvety black median stripe, rather than a pale scutum with brown stripes; antennae infuscated instead of entirely yellow.

Holotype.—Female, allotype male, Lone Pine, California, July 28, 1940 (R. H. Beamer). *Paratype.*—Males and females, Mammoth Lakes, California, July 29, 1940 (R. H. Beamer). Others same data as holotype. Types in the University of Kansas insect collection.

Simulium piperi Dyar and Shannon

Simulium piperi Dyar and Shannon, Proc. U. S. National Museum, 69: 38–39, 1927.

No specimens at hand. Described from a single male taken at Seattle, Washington, by Dyar and Shannon; "Entirely black, including legs; anterior half of mesonotum faintly and diffusely pale pollinose; thoracic pile brassy; scutellum fringed with black hairs; stem vein black pilose."

THE ELEMENTS OF STATISTICS, by ELMER B. MODE. Pages xvi and 378. 1941. 6¼x9¼ inches, linen. Published by PRENTICE-HALL, INC., 70 Fifth Avenue, New York, N. Y. Price $3.50.

The author, who is Professor of Mathematics at Boston University, has designed this text for use in a course in general introductory statistics. It is directed at no particular field of interest. In fact students of economics, psychology, education, biology, and other disciplines will find discussed here the basic principles and practices common to all fields. The chapters are largely devoted to expositions of the methods of descriptive statistics for large samples. After introductory chapters dealing with methods of computation, charts, diagrams, graphs, and frequency distributions, the author discusses the various useful positional averages, including index numbers, the common measures of dispersion, and the statistics of curve form. These topics are followed by discussions of the normal frequency curve, curve fitting, and correlation. The binomial distribution, which actually occupies a central position in the development of statistical theory, is given an apparently unimportant place in the next to the last chapter. The Poisson distribution is treated on a single page. To students of economic field entomology, who use this distribution frequently, this may be regarded as a shortcoming. The final chapter deals with the sampling errors of common statistics. This should serve as a transition to a study of statistical tests of significance of differences which are not treated in this text.

A set of mathematical tables commonly needed in statistical work supplements the text. A short list of books and journals, classified according to field, will help to introduce the student to other expositions of statistical methods.

—E. L. GREEN.

REVISION OF THE GENUS COPHURA OSTEN SACKEN

(Diptera: Asilidae)

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The exact limitations of *Cophura* have been a subject of speculation among American workers since Osten Sacken (1886) described the genus. Various writers have added species to the genus with the understanding that it is heterogeneous, including diverse forms. No treatise of relationships has been attempted, probably because of the difficulty of getting together described species. Most of these species are known in literature only by the original descriptions, and limited special collecting in the southwestern States has given the impression that they are rare. Largely due to the success of rather recent collecting, the author has been able to accumulate nearly all the known species and so enabled to make a comprehensive revision.

Loew in 1872, erected the genus *Blax* for his species *bella* from Texas. *Blax* was later found to be preoccupied; *Blacodes* Loew (1874) and *Loewiella* Williston (1896) were new names proposed in turn for *Blax*, both of which likewise were found to be preoccupied. Osten Sacken (1886) erected the genus *Cophura* for *sodalis* Osten Sacken from Presidio, Mexico, differentiating *Cophura* from *Blacodes* on a basis of the length of the antennal style. Williston (1901) considered *Blacodes* identical with *Cophura*, further adding several species previously ascribed to *Nicocles* Jaennicke, *Aphamartania* Schiner, and *Taracticus* Loew. Other workers then added new species to the genus.

Seven years later, Hine (1908, p. 203) stated, "There seems to be some uncertainty as to the limits of the genus *Cophura* as used by different authors. . . . It is probable that when a critical study of sufficient material is possible the limits of *Cophura* will be restricted." The next year, Back (1909, p. 377) said, "I firmly believe that the genus *Cophura* as it stands, is more or less of a repository for small asilids of this subfamily that have the front tibiae armed with a terminal claw-like spur and do not fit into any of the other genera. . . . Personally I believe that *sodalis* is distinct from the other species now in the genus. To my knowledge, the only material of this genus in American collections is the type specimens except in the case of *cristata* and *fallei*." The first attempt at reducing this "repository" was made by Curran (1923) in establishing the genus *Comantella* for these last two species mentioned by Back. Melander (1923, p. 209) reiterated, "The genus *Cophura* has been heterotypic, serving to combine various species that run to it in the keys, without regard to their phylogeny. The separation of *Comantella* helps to unify the group, but it is still diverse. The species are considered rare, only the type material being known of most of its forms." Several other species have been separated by Curran under the genus *Buckellia*, with the genotype *Cophura albosetosa* Hine, but he refrained

from drawing its limits until a comprehensive revision of *Cophura* could be made or at least the genotype studied. *Buckellia* was included in the key to *Cophura* which Curran presented in 1931, largely drawn up from the descriptions. *Cophura panamensis* Curran was recently transferred to the genus *Aphamartania* Schiner (Pritchard, 1941).

Thirty-four species are included in *Cophura* in this revision. Two proposed names which are doubtfully worthy of recognition are retained as varieties. The material examined includes all the species except one, *vitripennis* (Curran) the relationships of which are well established by its describer. Nearly all of the types have been examined. Over five hundred specimens have been studied. The range of the genus has been extended to include South America.

After a preliminary study, it was the writer's impression that there were four major groups worthy of generic rank: a SODALIS GROUP with four species, an ALBOSETOSA GROUP with three species, a BREVICORNIS GROUP with two species, and a FUR GROUP with eighteen species. The eighteen species in the FUR GROUP included two divergent species, *clausa* (Coquillett) and a new species from Nebraska. These two species are more distantly related to the rest of the group and widen its limits. Three additional species, each having bristles over the face, and a new species from Arizona could also have been added to the FUR GROUP, but at the expense of making it still more heterogeneous. Of the remaining species, *sculleni* Wilcox could have been included with the SODALIS GROUP, because this is its closest relationship; but this group is then made rather heterogeneous. *Bella* Loew and a closely allied new species from Mexico, although perhaps also referable to the SODALIS GROUP, possess characters which set them apart. It was then found inexpedient to separate the widened SODALIS and FUR GROUPS. With these united into one large group, it seems unwarranted to elevate the ALBOSETOSA and BREVICORNIS GROUPS to generic rank. It was also deemed unadvisable, if not unjustifiable at the present, to give generic standing to the species not fitting well into larger groups.

For the purpose of this revision, in order to facilitate determination and in order to establish more definitely and easily the morphological relationships, the four major groups are recognized as such, the three species with bristles over the face are recognized as a group, *bella* and its ally are recognized as a group, and the two remaining species are treated individually as representing separate groups. The known species are briefly recharacterized, and notes are given on geographical distribution and seasonal occurrence. Fourteen species are described as new. Diagnostic descriptions of previously known species are largely based on coloration and vestiture and should be considered supplementary to descriptions and comparative notes on the groups which are based principally on morphological characters.

Nothing is known concerning the immature forms of members of this genus. The adults of many species of the FUR and SODALIS GROUPS are found on the tips of grasses or dead twigs of branches, while some species of the FUR GROUP are ground inhabitants. A winged termite has been taken as prey of *Cophura acapulcae*.

The fossil asilid, *Cophura antiquella* Cockerell has been described from the Miocene shales of the Florissant in Colorado. The abdomen

was described as having pollinose markings much as in *fur* (Williston), but the anal cell was described as being closed and petiolate which is not characteristic of *fur* and more closely related species.

For assistance in this study, the writer wishes sincerely to acknowledge his thanks to Mr. Joseph Wilcox who turned over to him some preliminary work on the group, to Dr. R. H. Painter, Dr. R. H. Beamer, Mr. Nathan Banks, Dr. C. H. Curran, Dr. S. W. Bromley, Dr. F. W. Edwards, Mr. H. Oldroyd, Mr. M. T. James, Mr. D. E. Hardy, Prof. M. H. Swenk, Mr. E. G. Anderson, and Mr. C. F. W. Muesebeck, especially for the loan of material, and to Dr. C. E. Mickel and Dr. A. A. Granovsky for advice concerning the execution of this paper.

Genus **Cophura** Osten Sacken

1872. *Blax* Loew (preoccupied by Koch, 1840; Thompson, 1860; Candèze, 1863), Berl. Ent. Zts., 16: 65. Genotype, *Blax bellus* Loew.
1874. *Blacodes* Loew (preoccupied by Dejean, 1834), Berl. Ent. Zts., 18: 377. Genotype, *Blax bellus* Loew.
1886. *Cophura* Osten Sacken, Biol. Centr.-Amer., Dipt. I: 181. Genotype, *Cophura sodalis* Osten Sacken.
1896. *Loewiella* Williston (preoccupied by Meunier, 1894), Manual N. Amer. Dipt.: 57. Genotype, *Blacodes bellus* (Loew).
1901. *Cophura* Williston, Biol. Centr.-Amer., Dipt. I, suppl.: 314.
1909. *Cophura* Back, Trans. Amer. Ent. Soc., 35: 375.
1923. *Cophura* Melander, Psyche, 30: 208.
1925. *Buckellia* Curran, Canad. Ent., 57: 156. Genotype, *Cophura albosetosa* Hine. New synonymy.
1931. *Cophura* Curran, Amer. Mus. Nov., 487: 4.

The genus is characterized and separated from all other asilid genera by having the antennal style slender, two segmented, bearing a distal seta which is centrally placed and not situated in a depression; face projecting very little, flat above or gently convex, but little divergent below; prosternum reduced to an isolated plate; mesonotum without a median crest of hairs; anterior tibia with a slender, terminal, sigmoid spur; pulvilli well developed; two submarginal and five posterior cells open at margin; terminal segments of male abdomen unmodified; superior forceps of male genitalia divided but broadly attingent at base; and female ovipositor with spined acanthophorites.

Genotype.—*Cophura sodalis* Osten Sacken, by original designation.

Distribution.—Restricted to the New World; known from British Columbia, western and southwestern United States, Mexico, Ecuador, and Peru.

KEY TO GROUPS AND SPECIES

1. Scutellum entirely pollinose 2
   Scutellum with broad posterior margin largely or entirely bare of pollen 27
2. Wings somewhat ovoid, largely or entirely dark brownish (SODALIS GROUP) 3
   Wings elongate, slender, hyaline or essentially so, the veins sometimes clouded 6
3. Posterior femora yellowish 4
   Posterior femora largely black 5
4. Face with moderately long hairs on either side; presutural dorsocentrals prominent (southern Mexico) (p. 290) ..... **daphne**
   Face with scant setae; presutural dorsocentrals lacking (northern Mexico), (p. 289) ..... **sodalis**

5. Male with abdomen reddish (southern Mexico), (p. 289) ..... **humilis**
Male with abdomen black (southern Mexico), (p. 290) ..... **willistoni**
6. Mystax composed of strong bristles over face nearly to antennae (TRUNCA GROUP) 7
Mystax with bristles oral, on less than lower half of face (FUR GROUP) 9
7. Vein R_4 (Comstock system) with stump of sectoral cross-vein; scutellum with two strong bristles; hind coxa with an elongate tubercle anteriorly; tibiae and tarsi reddish; abdomen partly shining (California), (p. 294), **trunca**
Vein R_4 without stump vein; scutellum with long marginal hairs; hind coxa without tubercle; tibiae and tarsi mostly black; abdomen entirely pollinose 8
8. Wings gray; r-m cross-vein but little beyond middle of discal cell; abdominal dark fasciae covering proximal three-fourths of each segment (Ecuador), (p. 295) ..... **sundra**
Wings with veins bordered with brown; r-m cross-vein at three-fourths the length of discal cell; abdominal dark fasciae covering proximal half of each segment (Peru), (p. 294) ..... **zandra**
9. Anal cell closed and short petiolate; tibiae and tarsi yellowish (California), (p. 296) ..... **clausa**
Anal cell open 10
10. Femora yellowish except at distal end; posterior coxa without anterior tubercle; mesonotum white pilose; abdomen shining black with lateral pollen (Nebraska), (p. 296) ..... **dora**
Femora largely or entirely black; posterior coxa with anterior tubercle; mesonotum with short setae and outstanding bristles or with erect brown hair 11
11. Abdomen largely bare of pollen dorsally and shining black 12
Abdomen entirely pollinose, except caudal segments of female 15
12. Legs with proximal half of tibiae yellowish; cinereous pollen of abdomen forming a lateral stripe (Texas, Oklahoma), (p. 298) ..... **texana**
Legs entirely black; cinereous pollen of abdomen lateral, but projecting inward on each segment 13
13. Abdominal cinereous pollen extending inward along anterior margin of the segments, meeting to form fasciae on two, three, and four (New Mexico), (p. 298) ..... **ameles**
Abdominal cinereous pollen extending inward along posterior margins of the segments, well separated dorsally 14
14. Mesonotum with conspicuous, erect, brown hair (southern Mexico), (p. 297), **pulchella**
Mesonotum nearly bare (Arizona), (p. 297) ..... **fur**
15. Anterior calli of mesonotum bearing short bristles 16
Anterior calli of mesonotum only pollinose 20
16. Femora black 17
Femora with at least middle pair yellowish behind 19
17. Anterior four tibiae reddish, infuscate at tip; abdomen ochreous-brown fasciate (southern Mexico), (p. 299) ..... **cora**
Anterior four tibiae black or with not over proximal two-thirds of anterior pair and proximal third of middle pair yellowish; abdomen dark brown fasciate 18
18. Dorsocentrals postsutural; mesonotal and scutellar bristles white, sometimes brown in part; typically with anterior four tibiae reddish proximally; abdominal fasciae even; male genitalia with short hairs (Arizona), (p. 299) ..... **arizonensis**
Dorsocentrals strong anterior to transverse suture; mesonotal and scutellar bristles all black; legs entirely black; abdominal fasciae much narrowed medially; male genitalia with long pile (southern Mexico), (p. 300) ... **igualae**
19. Mesonotal and scutellar bristles black; abdomen dark brown fasciate; one pair of marginal scutellars (southern Mexico), (p. 301) ..... **atypha**
Mesonotal and scutellar bristles pale; abdomen rich brown pollinose above; two pairs of marginal scutellars (southern Mexico), (p. 301) ..... **apotma**
20. Scutellum without bristles 21
Scutellum with marginal bristles 22

21. Legs black; body cinereous pollinose with dark brown markings (southern Mexico), (p. 302) ..... **acapulcae**
Legs with tibiae reddish-yellow proximally; body reddish-brown pollinose with dark brown markings (southern Mexico), (p. 303) ..... **calla**
22. Scutellum with a single pair of marginal bristles 23
Scutellum with two or three pairs of marginal bristles 25
23. Posterior femora with numerous long bristles below, without fine hairs; femora usually with distal ends reddish, especially posteriorly; abdomen uniformly cinereous pollinose (Oklahoma, Kansas, Colorado, Texas), (p. 304) ..... **stylosa**
Posterior femora with three or four slender bristles below and a few short, fine hairs; femora entirely black; abdominal pollen brown or brownish fasciate 24
24. Abdomen with dorsum uniformly dark brown pollinose contrasting with a lateral cinereous stripe; wings largely fuliginous on distal half; median plate of male genitalia sharply convex distally, without indentation (Arizona), (p. 304) ..... **hesperia**
Abdominal tergites cinereous pollinose posteriorly; wings hyaline; median plate of male genitalia nearly flat with a median indentation on distal third (Arizona), (p. 304) ..... **pollinosa**
25. Anterior tibiae black; abdominal tergum dark brown pollinose with a cinereous stripe on each side (Arizona), (p. 305) ..... **vera**
Anterior tibiae reddish-yellow on proximal three-fourths 26
26. Abdomen cinereous pollinose or tinged with brownish dorsally (Colorado, Arizona, New Mexico, Texas), (p. 305) ..... **lutzi**
Abdomen cinereous pollinose, with dorsal brown fasciae (Oklahoma), (p. 305) ..... **lutzi** var. **wilcoxi**
27. Posterior coxa without tubercle 28
Posterior coxa with elongate tubercle anteriorly 29
28. Face with only oral bristles and hairs, and at narrowest point fully two-thirds as wide as width of one eye; thorax nearly bare of hairs and bristles; wings long and slender; hind tibiae slender; brown species with brown legs and hyaline wings (PAINTERI GROUP), (Arizona), (p. 293) .. **painteri**
Face hairy, at narrowest point about one-half as wide as width of one eye; thorax pilose; wings broad at base and strongly tapering; hind tibiae stout, enlarged; species with black thorax, yellow abdomen and legs, and with wings dark brown on proximal two-thirds (SCULLENI GROUP), (Arizona, New Mexico), (p. 291) ..... **sculleni**
29. Anal cell closed and petiolate; scutellum nearly as long as wide, somewhat triangular, the caudal margin with a bare spot on either side; wings broadly rounded; mesonotum with dorsocentrals well differentiated; reddish species with brown wings (BELLA GROUP) 30
Anal cell open; scutellum twice as wide as long, the caudal margin well rounded and entirely bare of pollen; wings elongate; mesonotum without dorsocentrals well differentiated; black species with more hyaline wings ... 31
30. Mesonotal pollen of male white anteriorly, gradually diffusing posteriorly into the ochreous pollen; five pairs of dorsocentrals (Texas, New Mexico), (p. 291) ..... **bella**
Mesonotal pollen of male very densely white anteriorly, extending posteriorly three-fifths of distance to transverse suture, and sharply differentiated from the yellowish-brown mesonotal pollen; one pair of strong dorsocentrals (northern Mexico), (p. 292) ..... **nephressa**
31. Mesonotum clothed with stout setae; scutellum without discal hairs, the caudal margin with one or two pairs of bristles; face nearly bare of hairs above; abdomen punctate (BREVICORNIS GROUP) 32
Mesonotum clothed with erect hairs; scutellum hairy, with a marginal row of long hairs; face clothed with erect hairs; abdomen smooth (ALBOSETOSA GROUP) 34
32. Tibiae with appressed hairs white (New Mexico), (p. 306) ..... **caca**
Tibiae with appressed hairs black 33
33. Legs castaneous (Washington, Oregon, Colorado, Nebraska), (p. 306), **brevicornis**
Legs black (Idaho, Montana, California), (p. 306), **brevicornis** var. **melanochaeta**

34. Legs entirely black 35
Legs with broad apices of femora, tibiae except apices, and bases of first two or three tarsal segments pale yellowish; wings hyaline (British Columbia), (p. 308) ..... **vitripennis**
35. Wings with cross-veins and furcations broadly clouded with brown (Washington, Oregon), (p. 307) ..... **scitula**
Wings hyaline, or essentially so in male (British Columbia, Washington, Oregon, Utah), (p. 308) ..... **albosetosa**

COMPARATIVE NOTES ON THE GROUPS

The shape of the face and the composition of the mystax have been considered paramount by some workers for splitting *Cophura*. With all the species at hand, these characters do not lend themselves to ready differentiation into groups, and in correlation with other characters cannot be considered of generic value at the present. The face at its narrowest point just below the antennae is about one-half the width of one eye in SCULLENI, three-fifths the width of one eye in FUR and TRUNCA, and about two-thirds the width of one eye in the other groups, but the differences are not well delimited. As seen from the side, the face is distinctly and evenly convex in ALBOSETOSA and nearly so in BREVICORNIS, and rather evenly rounded but not produced in SCULLENI and *dora*. In the other groups the face is not receding orally, and in TRUNCA is built up to a well marked supra-oral projection. The face is gently curved to the oral projection in the remaining groups, but flattened above in some species of FUR. The bristles of the mystax cover most of the face in TRUNCA, but are mostly oral in the other groups. The hairs on the face are small and scant in PAINTERI, BELLA, BREVICORNIS, and in most species of FUR and SODALIS; longer, moderate to rather dense in SCULLENI, a few species of FUR, and ALBOSETOSA. The antennal style is shorter than the length of the second antennal segment in SODALIS, SCULLENI, and PAINTERI, as long as the second antennal segment or longer in the other groups.

The entire absence of scutellar hairs or bristles does not usually occur in SODALIS as indicated by Osten Sacken (1886) and used by Curran (1934) and James (1941) to separate *Cophura* from *Buckellia*, but this condition does occur in two species of FUR. The use of the lack of marginal pollen of the scutellum as a primary division in the key is not necessarily a character for separating groups, but it is warranted by the convenience of this character with the material at hand.

The middle tibia at the tip inside bears a single, significant black spine in SODALIS, SCULLENI, PAINTERI, and BELLA; two divergent terminal spines in *clausa* and *dora*, one spine of which is usually yellow-

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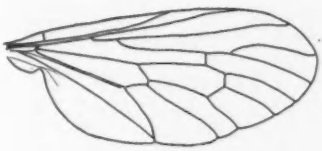
EXPLANATION OF PLATE I

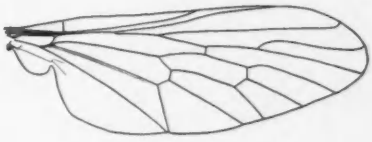
1. Wing of *Cophura bella* (Loew); Estancia, New Mexico; August 11, 1931. 2. Wing of *C. sculleni* Wilcox; holotype, male. 3. Wing of *C. sodalis* Osten Sacken; cotype, female. 4. Wing of *C. fur* (Williston); Phoenix, Arizona, April 13, 1931. 5. Anterior and lateral views of head of *C. sodalis* Osten Sacken; cotype, female. 6. Anterior and lateral views of head of *C. brevicornis* (Williston); Puyallup, Washington, July 27, 1935; female. 7. Anterior view of head of *C. fur* (Williston); Phoenix, Arizona, April 19, 1931; female. 8. Lateral view of head of *C. zandra*, new species; holotype, female. 9. Anterior view of head of *C. sculleni* Wilcox; holotype, male. Figures 1–4 drawn to same scale; figures 5–9 drawn to same scale.



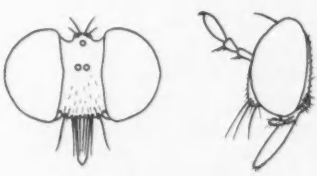
1. BELLA

2. SCULLENI

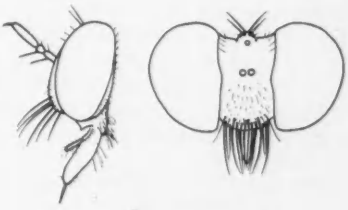
3. SODALIS



4. FUR

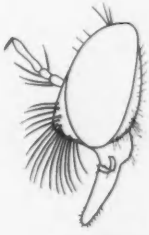


5. SODALIS

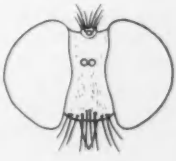


6. BREVICORNIS

7. FUR



8. ZANDRA



9. SCULLENI

ish; and at least a pair of adjacent black spines in the other groups. The posterior coxa is without an anterior tubercle in SODALIS, SCULLENI, PAINTERI, two species of TRUNCA, and one species, *dora*, included in FUR, but bears an elongate tubercle in the other groups. This tubercle is not necessarily of importance, but with the species at hand seems to indicate close relationships.

The wings are broad proximally and tapering distally in SODALIS and SCULLENI, more broadly rounded in BELLA, and elongate in the other groups. The color of the wings is fumose, often lighter on the distal third in SODALIS; fumose, but hyaline on the distal third in SCULLENI; fumose with a costal clear spot in BELLA; and essentially hyaline or grayish, although often with flavescence or infuscation especially along the veins, in the other groups. The anal cell is closed and short-petiolate in SODALIS, BELLA, and *clausa*, closed in the margin in SCULLENI, and open or rarely closed in the margin in the other groups. Vein R_4 bears a long stump vein only in one species of TRUNCA; rarely there is an indication of this stump vein at the fork of R_4 and R_5 in ALBOSETOSA.

The ground color of the abdomen is reddish in SCULLENI, BELLA, and in most species of SODALIS; it is essentially black in the other groups. The abdomen is punctate in BREVICORNIS, smooth or pollinose in the other groups. The form of the abdomen does not lend itself readily to group division. The abdomen is rather broad and distinctly flattened in SODALIS and SCULLENI, more elongate, somewhat flattened to distinctly convex in the other groups.

SODALIS GROUP

Face distinctly rounded on lower third, receding orally very little, at antennae fully two-thirds the width of one eye; inner eye margins slightly divergent above and below antennae, about equally in both directions. Mystax sparse, composed of long oral bristles and from a few to moderately dense fine hairs above on either side which may be as long as first two antennal segments. Antennae with proximal two segments subequal, the third about one and one-third times the length of first two combined, parallel sided, tapering somewhat at distal end; style short, about half the length of first antennal segment, with a small distal seta, two segmented with the proximal division very short. Thorax entirely pollinose. Mesonotum moderately hairy or nearly bare, the dorsocentrals long, postsutural or over the entire dorsum. Scutellum convex, one-half as long as broad, well rounded on caudal margin which bears several pairs of small setae which are rarely over half as long as length of scutellum. Posterior coxa without an anterior tubercle; anterior tibia with distal spur slender, sigmoid; middle tibia with a single black distal spine inside; posterior tibia slender, evenly tapering to base; pulvilli nearly as long as the claws. Wings short and quite broad subproximally, tapering on distal half; fourth posterior cell but little narrowed; anal cell closed and short petiolate. Abdomen shorter than wings, quite flattened, tapering gradually from at or near base, especially in female; above bare or thinly pollinose. Male genitalia completely exserted, normally inverted; ninth tergite of female evenly rounded.

Within the single species *humilis* (Bellardi), there is found a series of antennal conditions ranging from the presence of a complete proximal segment in the style to the presence of this segment only as a small nodule at one side of the base of the style.

Cophura sodalis Osten Sacken

1886. *Cophura sodalis* Osten Sacken, Biol. Centr.-Amer., Dipt. I: 181.

A yellowish pollinose species with fumose wings and yellowish abdomen. Mesonotal vestiture very short and sparse; three pairs of short, yellow dorsocentrals posteriorly. Legs yellowish with brown infuscation on proximal two-thirds of anterior four femora, distal ends of anterior four tibiae and tarsi, distal third of posterior tibiae, and distal ends of posterior tarsal segments. Length, 5–8 mm.

Types.—Described and known only from one male and nine females from Presidio, Mexico; types deposited in the Museum of Comparative Zoology and the British Museum (Natural History).

Two cotype females have been seen, one from each museum. Two females from Lower California differ in having the abdomen dark brown and the thoracic setae more strongly developed; these probably represent a new species. A female from Ruby, Arizona (July 13, 1940), differs essentially in having the wings darker with the costal margin hyaline to the end of the marginal cell; this probably represents a new species.

Cophura humilis (Bellardi)

1861. *Dasypogon (? Heteropogon) humilis* Bellardi, Saggio Ditt. Mess., 2: 77.
1901. *Cophura sodalis* Williston (not Osten Sacken), Biol. Centr.-Amer., Dipt. I, suppl.: 314.

Face moderately clothed with fine white hairs on either side. Mesonotum covered with numerous erect setae, with long dorsocentrals over most of its length. Legs with femora black except tip; tibiae yellowish, black on tips of anterior two pairs and on distal third of posterior pair; tarsi blackish. Wings fuscous, the distal third or more usually lighter and sometimes nearly hyaline. Abdomen yellowish in both sexes, usually blackish at base and tip, and to a variable extent below. Length, 6–9 mm.

Types.—Described from Cuantla, Guerrero, Mexico, from one male; probably at the Museum of Geneva.

Although Bellardi has apparently overlooked the tibial spur, there is little doubt but that his species belongs here. Williston recorded two females from Guadalajara, Jalisco, Mexico, under the name of *Cophura sodalis;* these specimens are in the British Museum (Natural History), and have been examined by the writer. A large series was taken by the writer at Acapulco, Guerrero, Mexico (June). It was found to be abundant on the tips of low weeds along the coast, being replaced by *Cophura acapulcae* in the adjacent coastal range. The species bears a striking resemblance to *Holcocephala abdominalis* (Say); both Osten Sacken and Back commented on this with regard to *sodalis*. It might be noted that the types of wing and abdominal shapes among the species of *Holcocephala* Jaennicke are as diverse as among the species of *Cophura*.

Cophura willistoni, new name

1901. *Cophura humilis* Williston, Biol. Centr.-Amer., Dipt. I, suppl.: 315 (preoccupied by Bellardi, 1861).

The male of this species differs from *humilis* (Bellardi) by having the abdomen black with the segmental posterior margins narrowly yellow. The female ascribed to the species by association is hardly differentiable from Bellardi's species.

Types.—Williston described the species from a male and female, Tepetlapa, Guerrero, Mexico; types probably in the British Museum (Natural History).

The author took four males and one female at Iguala, Guerrero, Mexico (June).

Cophura daphne, new species

Black, with yellowish pollen and vestiture, the abdomen and legs except tarsi and distal half of posterior tibia yellowish; wings brown, paler distally. Length, 7.5 mm.

Male.—Head light yellowish pollinose; vestiture light yellowish, the beard and hairs on the face nearly white. Mystax composed of a row of oral bristles and moderately long hairs on either side of the face extending nearly to the antennae; four ocellars longer than proximal two antennal segments; parafrontals longer than proximal antennal segment. Thorax and coxae ochreous pollinose, the mesonotum with geminate median vitta and wide lateral vittae thinly brown pollinose, largely shining black. Thoracic vestiture yellowish; mesonotum covered with numerous erect setae anteriorly; dorsocentrals extending presuturally. Scutellum entirely pollinose, with five pairs of marginal setae. Legs yellowish, the posterior tibia blackish on distal half, the anterior four tarsi blackish distally, the posterior tarsi blackish. Wings deeply fuscous, paler on distal third and in the cells of the anal field; anal cell closed and petiolate. Abdomen yellowish with sparse pale yellow setae, and lateral yellowish bristles on first segment. Genitalia reddish-yellow, black distally, clothed with yellowish bristles.

Holotype.—Male, Cuernavaca, Morelos, Mexico, 1923 (E. G. Smyth) in the United States National Museum.

Daphne differs from other members of the SODALIS GROUP by having the face more produced, the hairs of the face denser and longer, the ocellars and the parafrontals much stronger. This species is most closely related to *humilis* (Bellardi) which, however, does not have yellow femora.

SCULLENI GROUP

This group differs from the SODALIS GROUP to which it is closely related, by having the face more evenly curved and narrower, at its narrowest point just below the antennae but little over half the width of one eye; front nearly parallel sided; facets of the eyes smaller; scutellum broadly bare of pollen on its caudal margin; posterior tibiae

much stouter; anal cell narrowly open or closed in the margin; and male genitalia concealed from above.

Cophura sculleni Wilcox

1937. *Cophura sculleni* Wilcox, Pan.-Pac. Ent., 13: 39.

Thorax yellowish-gray pollinose; mesonotum clothed with moderately dense, fine white hairs, with dorsocentrals postsutural; scutellum with shining black posterior margin, with several marginal hairs about as long as scutellum. Legs yellowish with distal ends of tibiae and most of tarsi black. Wings with proximal two-thirds fumose, the distal third clear hyaline and contrasting. Abdomen reddish, black at base. Length, 7 mm.

Types.—Holotype, male, Holbrook, Arizona (June), in the collection of Mr. J. Wilcox; and allotype, female, Estancia, New Mexico (July), in the collection of Dr. S. W. Bromley.

Specimens examined are the holoytpe; one male, three females, Alamorgordo, New Mexico, June 26, 1940 (D. E. Hardy); one male, two females, 25 miles west of Tularosa, New Mexico, July 1, 1940 (D. E. Hardy).

BELLA GROUP

This group exhibits very close relationships to *Nicocles* Jaennicke, differing only in having the terminal abdominal segments of the male undilated. It differs from the SODALIS GROUP by having the scutellum a little longer, subtriangularly shaped, bare of pollen on either side, marginally with two scutellars and a few small hairs; hind coxae with anterior tubercle; abdomen slender, well rounded above; posterior tibia enlarged at distal end; and male genitalia concealed from above. BELLA differs from the FUR GROUP principally by having the scutellum as described; wings rather oval; anal cell closed and petiolate; middle tibia with a single spine inside at tip; and male genitalia completely concealed from above.

Cophura bella (Loew)

1872. *Blax bellus* Loew, Berl. Ent. Zts., 16: 63.
1874. *Blacodes bellus* Loew, Berl. Ent. Zts., 18: 377.
1885. *?Aphamartania bella* Williston, Trans. Amer. Ent. Soc., 12: 54.
1896. *Loewiella bella* Williston, Manual N. Amer. Dipt.: 57.
1901. *Cophura bella* Williston, Biol. Centr.-Amer., Dipt. I, suppl.: 314.
1909. *Cophura bella* Back, Trans. Amer. Ent. Soc., 35: 379.
1934. *Cophura bella* Bromley, Ann. Ent. Soc. Amer., 27: 102.

A reddish species with yellowish vestiture. Face white pollinose; mystax composed of oral bristles and a few small hairs above on either side. Thorax ochreous pollinose. Mesonotum sparsely clothed with hairs, in male white pollinose on anterior half between calli and middorsal stripe; middorsal stripe brown, running full length of mesonotum; dorsocentrals long, yellowish, with two pairs presutural. Legs yellowish-red; femora brownish on distal half except tip, less so on posterior pair; tibiae blackish at tip, more so on posterior pair; tarsal segments with distal half brown. Wings fumose,

often with cells pale within, and with a nearly hyaline spot between the furcation of R_4 and R_5 and the costal margin. Abdomen shining yellowish or reddish, white pollinose laterally except on caudo-lateral corners of tergites which are often blackish in ground color, especially on posterior segments. Length, 6–9 mm.

Types.—Cotypes, male and female, Texas; in the Museum of Comparative Zoology.

This species has been unrecognized since described. Other specimens examined are two males, five females, Estancia, New Mexico, August 10–11 (R. H. Painter), and two males, four females, Gran Quivera, New Mexico, August 13, 1931 (R. H. Painter).

Cophura nephressa, new species

Body black except scutellum, abdomen and legs in part yellowish; pollen yellowish-brown except for white face and front, anterior coxae, and sharply outlined area anteriorly on mesonotum. Wings brown with a costal clear spot. Length, 9 mm.

Male.—Face and front densely white pollinose; occiput yellowish pollinose. Mystax composed of a mixed row of yellowish bristles and several fine white hairs above on either side; ocellars two, long and yellowish. Second antennal segment slightly longer than first; third twice as long as proximal two combined; style nearly as long as first two antennal segments combined. Thorax largely yellowish-brown pollinose, the coxae lighter and the anterior coxae white; the mesonotal area between the anterior calli and covering three-fifths of the distance anterior to the transverse suture densely white pollinose and strongly contrasting; median and lateral vittae of mesonotum dark brown pollinose, the median vitta being widely divided and largely obscured anteriorly. Mesonotal setae nearly lacking; two strong dorsocentrals and four lateral bristles yellowish. Scutellum subtriangular, yellowish in ground color, thinly ochreous pollinose except for shining bare spot on either side of caudal margin, with several yellowish scutellars. Legs largely reddish, fuscous above on femora and on distal ends of tibiae and tarsal segments; clothed with yellowish hairs and bristles. Wings brownish, darker distally and proximally to a costal hyaline spot which is at the end of the submarginal cell; anal cell closed and petiolate. Abdomen elongate, yellowish, nearly bare.

Holotype.—Male, Galeana, Nuevo Leon, Mexico, 5–6000 ft., August 2, 1939 (Ralph Haag); in the Musuem of Comparative Zoology.

Closely allied to *bella* (Loew) from which it differs mainly in being considerably more elongate, in lacking evident mesonotal setae anteriorly, and in having only one pair of well developed dorsocentrals; and by having the white pollinose area of the male mesonotum denser and strongly contrasting.

PAINTERI GROUP

This group could probably be united with the FUR GROUP to which it is most closely related, but in many respects it is intermediate between this and the SODALIS GROUP. It differs from typical FUR by having

the face a little wider, antennal style shorter, scutellar margin broadly bare of pollen and clothed with a fringe of very short hairs, posterior coxa lacking the anterior tubercle, middle tibia with a single black spine inside at tip, and abdomen strongly flattened. PAINTERI differs from SODALIS by having the scutellum as described, wings elongate and nearly parallel sided, and anal cell open. The face is hardly flattened above, and but slightly projecting orally. The legs are slenderer than in any other species of *Cophura*. The pollinosity pattern of the abdomen is similar to that of the BREVICORNIS GROUP, but the integument is smooth and shining.

Cophura painteri, new species

A brown species with sparse white hairs and bristles. Legs brown; wings hyaline; abdomen shining brown with white pollen on anterior margins and caudo-lateral angles of the segments. Length, 6 mm.

Female.—Face, front, and vertex thinly brown pollinose; rear of head cinereous pollinose. Mystax white, oral, composed of four bristles in center, one on either side, and a few white hairs; ocellar tubercle with two white bristles. First antennal segment slightly longer than second; third nearly two and one-half times length of proximal two combined, strongly laterally compressed, tapering a little from near base; style a little less than length of second antennal segment. Thorax thinly whitish pollinose laterally, brownish pollinose above. Mesonotum with ill defined markings, clothed with inconspicuous, short, white hairs, and with only one strong pair of dorsocentrals. Scutellum cinereous pollinose, the posterior margin bare, shining, with a fringe of small, fine hairs. Legs slender, brownish, the tibiae paler proximally; clothing scant, white. Wings elongate, hyaline; veins light brown. Vein R_5 forming a straight line with R_{4+5}; r-m cross-vein at two-thirds length of discal cell; fourth posterior cell a little narrowed; anal cell narrowly open. Abdomen shining brown; side of segment one white pollinose; caudo-lateral angles of two to five with white pollinose trapezoids; anterior margin of two to five thinly white pollinose, the fasciae narrowed at center and on sides. Eighth tergite evenly rounded, the posterior margin slightly undulate.

Holotype.—Female, Safford, Arizona, VII–26 (F. M. Hall), in the collection of Dr. R. H. Painter in whose honor the species is named.

TRUNCA GROUP

Closely related to the FUR GROUP with which it might be placed. It differs by having the bristles of the mystax extending over the face nearly to the antennae, and the face built up to a well marked supraoral projection. In *sundra*, however, the face is low enough to be intermediate between this and the FUR GROUP. *Trunca* differs structurally from the two South American species included in this group principally by having the thorax more highly arched, vein R_4 having a well developed stump vein, and the posterior coxa with an elongate tubercle anteriorly.

Cophura trunca (Coquillett)

1893. *Blacodes truncus* Coquillett, Canad. Ent., 25: 34.
1909. *Cophura trunca* Back., Trans. Amer. Ent. Soc., 35: 383.
1916. *Cophura highlandica* Cole, Psyche, 23: 63, fig. New synonymy.

Body black, with cinereous and ochreous pollen and black and whitish vestiture. Length, 8–9 mm.

Male.—Mystax pale, upper bristles brownish; ocellar tubercle with four very long, strong black bristles and several small, white hairs; first two antennal segments with black bristles below, longer than the length of the two segments combined. Thorax ochreous pollinose; mesonotum with vestiture black except for yellow bristles on anterior calli; dorsocentrals long, along entire length of mesonotum, and with a row of black hairs between them; scutellum with two strong marginal bristles and discal and marginal hairs. Legs with femora black except tips; tibiae and tarsi yellowish. Wings hyaline with furcations and cross-veins broadly brown maculate. Abdomen with cinereous pollen narrowly along anterior margin of the segments which is unconnected with lateral pollen.

Female.—Differing in the abdomen which has the caudal segments reddish-brown in color; and pollen more extensive, covering each side from the middle of the anterior margin of each segment to the caudo-lateral corners, enclosing a lateral bare spot.

Types.—*Trunca* was described from two males and two females, Los Angeles Co., California (Coquillett), deposited in the U. S. National Museum; *highlandica* was described from a female, East Highlands, California (November), in the U. S. National Museum.

A male and female on the same pin *in copula* and two other females, all from Los Angeles Co., California (Coquillett), are in the U. S. National Museum; one female bears a red type label. The types of *highlandica* and *trunca* have been compared by the writer and found to be the same. *Cophura trunca* is very closely related to *Metapogon punctipennis* Coquillett and *Metapogon pictus* Cole, not only in facial and thoracic structure and wing venation, but also in abdominal pollinose markings. Were it not for the presence of the tibial spur in *trunca*, it would be considered cogeneric with these two species of *Metapogon*.

Cophura zandra, new species

Elongate species; body black, brown pollinose; the abdomen with dark brown fasciae. Legs black; wings with brown suffusion along the veins. Length, 10 mm.

Female.—Head anteriorly brown pollinose; posteriorly cinereous pollinose; vestiture yellowish to brown. Mystax reaching nearly to antennae, darker above, composed almost entirely of bristles; ocellar tubercle with eight brown bristles. Face just below the middle projecting beyond the eyes, as seen from the side, by a distance fully as long as the first antennal segment. Second antennal segment a little shorter than first; third twice as long as combined length of first two, laterally compressed, broadly coarctate near middle, tapering only at tip; style one-third as long as third segment. Mesopleura

brownish-cinereous pollinose. Mesonotum brown pollinose with wide middorsal and lateral vittae dark brown; clothed with inconspicuous brownish hairs; dorsocentrals long, dark brown, with several pairs presutural. Scutellum entirely brown pollinose, brown pilose, with eight long, marginal, whitish hairs. Legs black, the bases of the tibiae very narrowly reddish; vestiture yellowish to brown; long, pale hairs on the femora especially noticeable. Wings brownish, the veins all bordered with brown, especially dark at the base of radial sector. Discal cell very long, with r-m cross-vein at three fourths its length; medial cross-vein twice length of base of M_2; fourth posterior cell well narrowed; anal cell open. Abdomen elongate, sparsely white pilose laterally, with short brown and yellowish hairs; laterally with narrow cinereous pollinose stripe, dorsally with brown pollen, on proximal half of each segment dark brown forming fasciae which are a little extended at middle and on each side.

Holotype.—Female, Celendin, Cajamarca, Peru, July 3, 1936 (Felix Woytkowski), at the University of Minnesota.

Cophura sundra, new species

Slender species. Black, largely brown pollinose, the abdomen fasciate. Legs black; wings gray. Length, 8 mm.

Male.—Pollen of front dark brown, of face ochreous, behind head cinereous. Bristles of occiput and narrow oral margin pale yellowish. Mystax composed of black bristles, extending to antennae; several pairs of long bristles on first two antennal segments also black. Face supraorally, as seen from the side, projecting by a distance as great as the length of the first antennal segment. Second antennal segment slightly shorter than first; third twice as long as first two combined, laterally compressed, broadly constricted near middle; style one-half as long as third segment. Mesopleura brownish-cinereous pollinose; mesonotum largely dark brown pollinose. Hairs of pronotum and anterior calli pale yellowish; erect hairs on mesonotum and long dorsocentrals along entire length, black. Scutellum brownish pollinose, the disc pale pilose, the caudal margin with several pairs of long black hairs. Legs black, with pale vestiture. Wings evenly grayish. R-m cross-vein near middle of discal cell; medial cross-vein equal in length to base of M_2; fourth posterior cell not narrowed distally; anal cell open. Abdomen slender, clothed with yellowish setae and with whitish hairs laterally, dark brown pollinose on proximal three-fourths of each segment, ochreous pollinose on caudal fourth.

Holotype.—Male, Pondoa, Ecuador, December 1, 1938 (W. Clarke-McIntyre), at the University of Minnesota.

Paratypes.—Two males, Pondoa, Ecuador, December 1, 1938 (W. Clarke-McIntyre), in the writer's collection.

Closely related to *zandra*, differing essentially in being slenderer, having grayish wings, with the r-m cross-vein near the middle of the discal cell and the two veins at the end of the discal cell subequal, the fourth posterior cell wider distally, and the dark fasciae of the abdomen much broader. The hairs of the mesonotum, and the bristles of the face, antennae, and ocellar tubercle are black rather than brownish.

FUR GROUP

Differs from the SODALIS GROUP in having the face a little narrower, the posterior coxa with an elongate tubercle, wings slender with anal cell open, and elongate, not as distinctly flattened. *Clausa* diverges from the typical FUR by having the anal cell closed and short petiolate, abdomen well rounded above, and male genitalia smaller, mostly concealed from above, with the median plate and lateral forceps poorly developed. *Dora* diverges from the typical FUR by having the face receding orally, and the posterior coxa lacking the anterior tubercle.

Cophura clausa (Coquillett)

1893. *Blacodes clausus* Coquillett, Canad. Ent., 25: 34.
1909. *Cophura clausa* Back, Trans. Amer. Ent. Soc., 35: 381, pl. 9, fig. 7.
?1941. *Cophura clausa* James, Jour. Kans. Ent. Soc., 14: 33.

Body black with cinereous pollen and pale vestiture. Length, 6–8 mm.

Male.—Mesonotum with dark brown, geminate middorsal stripe; clothed with short hairs; with long dorsocentrals except at anterior end. Scutellum with two strong marginal bristles and a few short hairs on disc and margin. Legs with femora black; tibiae and tarsi reddish. Wings hyaline or with a faint brownish tinge. Abdomen above largely shining black; cinereous pollen forming caudo-lateral triangles, a median line on proximal half of each segment which is wider on posterior segments, and a narrow anterior margin on two, three, and four.

Female.—Similar to male, but abdomen with the tergum pollinose except for the posterior margins of the segments and sometimes a triangle in the middle of each side of segments two, three, and four.

Types.—Cotypes, three males and six females, Orange Co., California, deposited in the U. S. National Museum.

Two males and five females, Los Angeles Co., California (Coquillett), are in the U. S. National Museum; one female bears a red type label. Additional material examined includes a female, Balboa, California (October), and a female, San Pedro, California (Sept.). The record of *clausa* from Durango, Colorado (June), by James should not be accepted until checked. *Cophura clausa* is very closely related to *Metapogon gilvipes* Coquillett, both in body structure and wing venation, and would be considered cogeneric with this species but for the tibial spur.

Cophura dora, new species

Slender species. Black, cinereous pollinose and white pilose; abdomen with caudo-lateral pollinose triangles; wings hyaline with light yellow veins; legs largely yellowish. Length, 8–9 mm.

Male.—Head cinereous pollinose, with hairs and bristles white. Face covered with long, rather erect hairs and with oral bristles; ocellar tubercle with numerous long bristles. Second antennal segment slightly shorter than first; third but slightly longer than first two combined, broad near base and tapering to tip; style slender, nearly two-thirds as long as third segment. Thorax cinereous pollinose, the mesonotum light brownish. Mesonotum rather densely

white pilose, the bristles poorly differentiated. Scutellum entirely pollinose, without discal hairs, with two pairs of long marginal hairs. Legs largely bright yellowish; coxae blackish; the anterior two pairs of femora blackish above at distal end, and anterior two pairs of tibiae blackish at tip; posterior femora blackish on distal fifth, and posterior tibiae blackish on distal third; tarsi blackish, the bases of the segments yellowish. Vestiture of legs whitish, rather sparse. Wings hyaline, the veins light yellowish; anal cell open; fourth posterior cell but little narrowed. Abdomen elongate, convex above, subspatulate, segment two being constricted. Abdomen clothed with white pile laterally and below, white setae above; shining black, with cinereous pollinose triangles covering the caudo-lateral angles of the segments, forming a narrow lateral stripe, and less widely separated above on caudal segments. Genitalia black, the superior forceps yellowish distally; white pilose.

Female.—Similar, but the pollen on abdominal segments six and seven forming only a lateral stripe.

Holotype.—Male, Mitchell, Nebraska, July 29, 1912 (L. M. Gates), at the University of Nebraska. Allotype.—Female, Mitchell, Nebraska, August 5, 1912 (L. M. Gates), at the University of Nebraska. The holotype bears the label, "new genera and species," possibly by Paul R. Jones.

Paratypes.—One female, Mitchell, Nebraska, August 16, 1915 (E. M. Partridge); one female, Mitchell, Nebr., July 30, 1913 (L. M. Gates); and one female, Mitchell, Nebr., Aug. 6, 1913 (L. M. Gates).

Dora differs from all other members of the FUR GROUP by having the face more receding orally, by lacking the tubercle on the posterior coxa, by having the femora and tibiae bright yellowish except at tips, the mesonotum white pilose, and the abdomen rather spatulate. The pollinose pattern of the abdomen is similar to that of *fur*.

Cophura fur (Williston)

1885. *Aphamartania fur* Williston, Trans. Amer. Ent. Soc., 12: 53.
1901. *Cophura fur* Williston, Biol. Centr.-Amer., Dipt. I, suppl.: 314.
1909. *Cophura fur* Back, Trans. Amer. Ent. Soc., 35: 381, pl. 9, fig. 6.

Black, cinereous pollinose; especially characterized by having the vestiture sparse; the abdomen bare of pollen above, cinereous pollinose laterally with the pollen extending triangularly inward on the caudal margin of each segment. Legs black. Wings flavescent to a variable extent on distal half or two-thirds. Length, 7–9 mm.

Types.—One male from Arizona, which is at the University of Kansas.

This species has been unrecorded since described. Materal examined includes three males, five females, Phoenix, Arizona, April 13–18, 1931 (E. M. Painter).

Cophura pulchella Williston

1901. *Cophura pulchella* Williston, Biol. Centr.-Amer., Dipt. I, suppl.: 314.

Coloration and pattern similar to that of *fur*. Body, however, more robust and vestiture much denser. Wings light brownish.

Abdomen of male with pollen on fifth, sixth and seventh segments connected dorsally. Length, 8 mm.

Types.—Seven specimens, Venta de Zopilote, Guerrero, Mexico, 2800 ft.; partly in the American Museum of Natural History and probably partly in the British Museum (Natural History). Unrecorded since described.

Cophura ameles, new species

Related to *fur* from which it differs by having the wings clear hyaline, the veins yellowish rather than brown; and abdomen with cinereous pollen projecting triangularly inward on anterior margin of each segment, meeting to form fasciae on two, three, and four. Length, 9 mm.

Female.—Head cinereous pollinose, the vertex nearly bare. Mystax composed of a few oral bristles and a few short, fine white hairs above on either side. Proximal two antennal segments subequal, clothed with short, white bristles. Thoracic pleura cinereous pollinose, tinged with brown on mesopleura. Mesonotum brownish-cinereous pollinose, brown between anterior calli; vittae wide, thinly pollinose, recognizable by the black ground color; clothed with inconspicuous, small white hairs, white lateral bristles, and two pairs of small, hardly distinguishable dorsocentrals posteriorly. Scutellum entirely cinereous pollinose, with two pairs of white bristles on caudal margin. Legs black, the tibiae faintly reddish at extreme base; moderately clothed with white hairs and bristles. Wings hyaline; veins yellowish on proximal half. Fourth posterior cell a little narrowed; r-m cross-vein just beyond middle of discal cell; anal cell open. Abdomen black; anterior part of second division of first segment and caudal margins of all segments very narrowly yellowish in ground color; clothed with a few white hairs and bristles laterally on proximal segments and small white hairs above. Pollen cinereous, covering side of first segment, forming antero-lateral triangles on other segments which extend from middle on anterior margin to caudo-lateral angles; inner apices of pollinose triangles connected on two-four, more widely separated on caudal segments.

Holotype.—Female, Carlsbad, New Mexico, June 17 (E. M. & R. H. Painter), in the collection of Dr. R. H. Painter.

Cophura texana Bromley

1934. *Cophura texana* Bromley, Ann. Ent. Soc. Amer., 27: 92.

Mesonotum brown pollinose or with transversely divided lateral brown fasciae connected to middorsal one, and the middorsal fascia strongly widened anteriorly. Legs black with about proximal half of tibiae reddish. Wings hyaline with flavescence on distal half; veins brown. Abdomen largely shining black above, the anterior margin of each segment dark brown pollinose; each side with a continuous cinereous pollinose stripe. Length, 7–10 mm.

Types.—Holotype, male, and allotype, female, Comfort, Texas (July) at the Texas Agricultural Experiment Station.

The author has found this species in the Wichita Mts., at Craterville, Oklahoma (July), associated with *Holopogon texanus* Bromley. Specimens are also at hand from Brownwood, Texas (June).

Cophura arizonensis (Schaeffer)

1916. *Lasiopogon arizonensis* Schaeffer, Jour. N. Y. Ent. Soc., 24: 65.
1935. *Buckellia drakei* Pritchard, Amer. Mus. Nov., no. 813: 6. New synonymy.

Black; cinereous and brown pollinose. Mesonotum with bristles white or in part brown; dorsocentrals postsutural only; scutellum with one or two pairs of marginal bristles. Legs black, yellowish to a variable extent on proximal two-thirds of anterior tibiae and proximal third of middle tibiae. Wings hyaline. Abdomen cinereous pollinose with dorsal dark brown fasciae over proximal two-thirds of each segment. Length, 6–11 mm.

Types.—Of *arizonensis*, one male, Huachuca Mts., Arizona, in the U. S. National Museum; of *drakei*, one male, Oracle, Arizona (August), in the American Museum of Natural History.

Schaeffer's type has been examined. Numerous specimens are at hand from Globe, Mustang Mt., Santa Rita Mts., Cochise Co., Huachuca, and Patagonia, Arizona (July 27–August). Mr. Wilcox, who has monographed the genus *Lasiopogon*, first suggested the synonymy. *Lasiopogon* Loew, under which genus Schaeffer described the species, is closely related to the genera *Stichopogon* Loew and *Willistonina* Back, and quite remote from *Cophura;* however, there is a superficial resemblance in this case.

Cophura cora, new species

Black, cinereous and ochreous-brown pollinose; vestiture entirely pale; legs black, the tibiae largely yellow; wings hyaline; abdomen fasciate. Length, 6–8 mm.

Male.—Head white pollinose. Mystax white, composed of oral bristles and a few long hairs above on lower two-thirds of face. Ocellar tubercle with four yellow bristles. Antennae with proximal two segments subequal, clothed with white hairs and bristles; first segment below with several bristles as long as length of the segment; second segment below with long bristle as long as proximal two segments combined, on basal half laterally compressed; style slightly longer than second segment. Thorax cinereous pollinose, with suffused dorsal vittae ochreous pollinose. Mesonotum clothed with short yellowish and white hairs; dorsocentrals yellowish, extending well in front of transverse suture. Scutellum cinereous pollinose, marginally tinged with yellowish-brown; with two long, yellowish marginal bristles and several short white hairs on either side of disc. Legs with femora shining black, with appressed white hairs and a few white bristles; tibiae with anterior two pairs yellowish except for brownish suffusion at very tip; posterior pair yellowish only on basal fourth; tarsi black. Wings hyaline; r-m cross-vein just before middle of discal cell; anal cell open. Abdomen cinereous pollinose, with a broad brownish fascia on anterior two-thirds of each segment; conspicuously clothed with short pale hairs, longer on sides of first three segments.

Female.—Similar; seventh and eighth abdominal segments shining black.

Holotype.—Male, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard), at the University of Minnesota. *Allotype.*—Female, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard), at the University of Minnesota.

Paratypes.—Eighteen males, seven females, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard), in the writer's collection.

Allied to *arizonensis* (Schaeffer) from which it may be distinguished by the yellow anterior four tibiae, yellow base of hind tibiae; presence of presutural dorsocentrals; ochreous-brown pollinose fasciae on the abdomen; and smaller size.

Cophura igualae, new species

Black, cinereous and dark brown pollinose; vestiture pale except for mesothoracic bristles; legs black; wings hyaline; abdomen fasciate. Length, 6–8 mm.

Male.—Head white pollinose. Mystax white, extending nearly to antennae; composed of oral bristles and long hairs above, with shorter hairs on upper half. Ocellar tubercle with four yellow bristles and several shorter white hairs. Second antennal segment slightly shorter than first; hairs below on first segment about equal in length to bristle below on second; third segment twice as long as proximal two combined, laterally compressed on proximal half; style slightly longer than second segment. Thorax cinereous pollinose. Mesonotum thinly clothed with short, mostly brown hairs; bristles black; dorsocentrals extending nearly to anterior margin. Scutellum entirely cinereous pollinose; with several short white hairs on either side of disc; with two strong, black marginal bristles. Legs black, with white hairs and bristles. Wings hyaline; r-m cross-vein before middle of discal cell; anal cell open. Abdomen cinereous pollinose, with a dorsal dark brown fascia on each segment which covers anterior half at side, and is narrowed to anterior third in center; clothed with mostly brown short hairs above, and with white hairs laterally which are longer on first three segments. Genital armature black, clothed with long, white hairs.

Female.—Similar; eighth, seventh, and median line on sixth abdominal segments shining black.

Holotype.—Male, Iguala, Guerrero, Mexico, June 30, 1935 (A. E. Pritchard), at the University of Minnesota. *Allotype.*—Female, Iguala, Guerrero, Mexico, June 30, 1935 (A. E. Pritchard), at the University of Minnesota.

Paratypes.—Nine males, eight females, Iguala, Guerrero, Mexico, June 30, 1935 (A. E. Pritchard), in the writer's collection.

Related to *arizonensis* (Schaeffer) from which it differs in having the mesonotal and scutellar bristles always black; strong presutural dorsocentrals; legs always black; abdominal brown fasciae narrower and medially constricted; and male genitalia clothed with long white hairs.

Found in association with *Psilocurus caudatus* Williston and *Triclis argentifacies* Williston, all three being ground inhabiting species.

Cophura atypha, new species

Black; cinereous and brown pollinose; legs with anterior four femora and often posterior ones yellowish behind; anterior four tibiae yellowish; wings hyaline; abdomen dark brown fasciate. Length, 6–9 mm.

Male.—Head with pollen white, on vertex and front brownish. Mystax white, over face to antennae, composed of bristles on lower third and shorter hairs above. Ocellar tubercle with six brown bristles. Proximal two antennal segments subequal, the bristles below on both segments brownish, equal in length to that of the two segments combined; third segment twice as long as proximal two together, laterally compressed; style a little longer than second segment. Thoracic pleura cinereous pollinose. Mesonotum largely brown pollinose due to the wide vittae; clothed with short brown hairs and usual long black bristles; dorsocentrals with three pairs presutural. Scutellum entirely cinereous pollinose; with several small white hairs on either side of disc and a pair of strong black marginal bristles. Legs clothed with white hairs and bristles. Anterior two pairs with femora black, behind and above yellowish; tibiae yellowish; tarsi brownish. Posterior pair black, the femora behind narrowly yellowish especially at distal end. Wings hyaline, the distal third washed with gray; cross-vein r-m at proximal third of discal cell; anal cell open. Abdomen cinereous pollinose with dorsal dark brown fasciae, each fascia covering the posterior margin of one segment, extending over following one covering half of the segment at the middle and fully two-thirds of it at the side. Genital armature black with long white pile.

Female.—Similar; anterior four femora yellowish only behind; middle tibiae dark underneath; abdominal tergites eight, seven, and median line of six shining black.

Holotype.—Male, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard), at the University of Minnesota. *Allotype.*—Female, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard), at the University of Minnesota.

Paratypes.—Two males, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard); two males, one female, Chilpancingo, Guerrero, Mexico, June 28, 1935 (A. E. Pritchard); two males, one female, Iguala, Guerrero, Mexico, June 30, 1935 (A. E. Pritchard); in the author's collection.

Related to *arizonensis* (Schaeffer) from which it differs in having the mesonotal and scutellar bristles all black; presutural dorsocentrals present; legs with femora and tibiae of anterior two pairs largely yellowish; abdominal dark fasciae constricted medially; and male genitalia long pilose.

Cophura apotma, new species

Black; cinereous and rich brown pollinose; legs with middle femora behind and ends of other femora, anterior four tibiae and base of hind tibiae all castaneous; abdomen rich brown pollinose above with dark brown dorsolateral spots. Length, 6–9 mm.

Male.—Head white pollinose, the vertex tinged with brown. Mystax white, with mostly oral bristles and rather long hairs above to antennae. Ocellar tubercle with six brown bristles. First antennal segment slightly longer than second, with bristles below as long as the segment; second with bristles below as long as proximal two segments combined; third twice as long as basal two together, laterally compressed; style a little longer than second segment. Thoracic pleura cinereous pollinose with brownish tinges. Mesonotum brown pollinose with the three vittae wide, bare of pollen; clothed with short brown hairs and the usual bristles which are yellowish or brownish; five pairs of presutural dorsocentrals. Scutellum brown pollinose with two pairs of yellowish marginal bristles. Legs black in part, castaneous on ends of femora, broad posterior side of middle femora, anterior four tibiae, and narrow base of hind tibiae; clothed with white hairs and bristles. Wings hyaline, lightly tinged with flavescence on distal half; r-m cross-vein just beyond middle of discal cell; anal cell open. Abdomen rich brown pollinose; dark brown spots on anterior two-thirds of each segment on dorso-lateral portion; cinereous pollinose narrowly on lateral margins, widening caudally on each segment to area behind dark spot; clothed with short brown hairs and longer yellowish hairs on sides of proximal two segments. Genitalia with rather short pale hairs.

Female.—Similar; posterior femora behind and part of anterior femora behind reddish; caudal margins of abdominal tergites six and seven and all of eight bare of pollen and shining.

Holotype.—Male, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard), at the University of Minnesota. *Allotype.*—Female, Tehuacan, Puebla, Mexico, July 12, 1935 (A. E. Pritchard), in the author's collection.

Related to *arizonensis* (Schaeffer) from which it differs in having presutural dorsocentrals; mesonotal vittae largely bare of pollen; femora in part and anterior four tibiae reddish; and abdomen rich brown pollinose above.

Apotma and the related Mexican species having the anterior calli of the mesonotum bristly, and probably *arizonensis*, occur on the ground; the other species of the FUR GROUP occur aerially upon the tips of dead twigs.

Cophura acapulcae, new species

Black; cinereous and brown pollinose. Mesonotum dark brown pollinose; legs black; wings gray; abdomen dark brown pollinose above or with narrow caudal margin lighter. Length, 8–11 mm.

Male.—Face and front ochreous-brown pollinose; vertex brown pollinose; rear of head cinereous pollinose. Mystax white, a thin row of oral bristles and several short hairs above. Bristles on ocellar tubercle and proximal two antennal segments brownish. Second antennal segment three-fourths length of first; third hardly twice as long as proximal two combined; style slightly longer than second segment. Thoracic pleura cinereous pollinose, brownish above. Mesonotum dark brown pollinose except posteriorly and along suture

on either side of middorsal vitta; very scantily clothed with short brown hairs, three black bristles on each side, and two pairs of yellowish dorsocentrals. Scutellum entirely cinereous pollinose, without hairs or bristles. Legs black, with whitish hairs and very few bristles; anterior tibiae below with rather dense, long silky hair. Wings smoky gray; r-m cross-vein near middle of discal cell; anal cell open. Abdomen dark brown pollinose above, cinereous pollinose on sides and on caudal two segments; practically without hairs and bristles. Genital armature brown haired.

Female.—Similar; fascia just before caudal margin of each segment lighter, nearly cinereous pollinose; segments eight, seven, and caudal margin of six shining black.

Holotype.—Male, Acapulco, Guerrero, Mexico, June 11, 1935 (A. E. Pritchard), at the University of Minnesota. *Allotype.*—Female, Acapulco, Guerrero, Mexico, June 11, 1935 (A. E. Pritchard), at the University of Minnesota.

Paratypes.—Seventy-five males, twenty-five females, Acapulco, Guerrero, Mexico, June 9–18, 1935 (A. E. Pritchard), in the writer's collection.

Differs from all other species of *Cophura* except the following one in lacking scutellar hairs and bristles on the margin. Related to *hesperia* which has the tibiae largely reddish. One male had a winged termite as prey.

Cophura calla, new species

Black; brown and dark brown pollinose; with whitish to brownish vestiture. Legs black with about proximal half of tibiae reddish; wings brown-flavescent; abdomen with dark brown fasciae. Length, 9–12 mm.

Male.—Face ochreous pollinose; front, vertex, and upper occiput brown pollinose; rear of head otherwise cinereous. Mystax whitish, with mostly oral bristles and shorter hairs above nearly to antennae. Ocellar tubercle and first two antennal segments with brownish bristles. Second antennal segment three-fourths length of first; third twice as long as proximal two combined, tapering distally as seen from the side, compressed near base as seen from above; style slightly longer than second segment. Thoracic pleura cinereous-brown pollinose. Mesonotum brown pollinose with three wide vittae bare of pollen; clothed with brown setae and brownish bristles; without dorsocentrals. Scutellum brown pollinose, with several small brown discal setae, without marginal hairs or bristles. Legs black, tibiae reddish on about proximal half of anterior pair, about proximal two-thirds of posterior two pairs; clothed with whitish hairs and bristles and long hairs below on anterior tibiae. Wings brown-flavescent, especially on costal side of distal half; cross-vein r-m just beyond middle of discal cell; anal cell open. Abdomen brown pollinose with a medially constricted dark brown fascia on proximal half of segments two to five; seven and eight bare above; clothed with brown hairs and longer whitish hairs on sides of one and two. Genitalia with yellowish hairs.

Female.—Similar; abdominal segments eight, seven, six, and caudal margin of five shining black.

Holotype.—Male, Iguala, Guerrero, Mexico, June 30, 1935 (A. E. Pritchard), at the University of Minnesota. *Allotype.*—Female, Iguala, Guerrero, Mexico, June 30, 1935 (A. E. Pritchard), at the University of Minnesota.

Paratypes.—Twenty males, eighteen females, Iguala, Guerrero, Mexico, June 30, 1935 (A. E. Pritchard), in the writer's collection.

Related to *acapulcae* from which it differs in having the dorsocentrals lacking; tibiae reddish on proximal half; wings brownish; and abdomen rich brown pollinose with medially constricted dark brown fasciae on proximal half of the segments. Superficially resembles *zandra* very much.

Cophura stylosa Curran

1931. *Cophura stylosa* Curran, Amer. Mus. Nov., 487: 7.
1935. *Buckellia stylosa* Pritchard, Amer. Mus. Nov., 813: 6.

A light cinereous pollinose species with three bare, black mesonotal vittae; wings hyaline; femora usually reddish on ends and behind; and tibiae reddish except distal fifth. The antennal style is often as long as proximal two segments combined. Length, 8.5–12 mm.

Types.—One female from Woods Co., Oklahoma (July), in the American Museum of Natural History.

Specimens are at hand from Boise City, Oklahoma (July); Clarke Co., Kansas (June); Kiowa Co., Colorado (August 19); and Sweetwater, Texas (June 15).

Cophura pollinosa Curran

1930. *Cophura pollinosa* Curran, Amer. Mus. Nov., 415: 10.
1935. *Buckellia pollinosa* Pritchard, Amer. Mus. Nov., 813: 7.

A cinereous and light brownish pollinose species with brownish mesonotal vittae usually partially rubbed off; wings hyaline; femora black; tibiae reddish on proximal half to two-thirds; abdomen with light brownish fasciae which are often quite broad. Length, 7–10 mm.

Types.—Described from Baboquivari Mts. and Coyote Mts., Arizona (August), in the American Museum of Natural History.

Material is at hand from Tucson, Sells, Tubac, and Pima Co., Arizona, all taken in August. A female from Tucson, taken in May, is larger and has the abdomen largely brown pollinose dorsally with the segmental posterior margins yellowish in ground color; this may represent another species.

Cophura hesperia (Pritchard)

1935. *Buckellia hesperia* Pritchard, Amer. Mus. Nov., 813: 7.

Cinereous and brown pollinose; mesonotal vittae entirely brown pollinose, the median stripe geminate; wings flavescent on distal half; femora black, tibiae reddish except distal fourth; abdomen with dorsum dark brown pollinose, laterally cinereous pollinose. Length, 8–10 mm.

Types.—Two males and two females, Tucson, Arizona (August);

holotype and allotype in the American Musuem of Natural History. Known only from type material.

Cophura vera (Pritchard)

1935. *Buckellia vera* Pritchard, Amer. Mus. Nov., 813: 8.

Cinereous and brown pollinose; mesonotal vittae wide, brown pollinose; wings tinged with brownish on distal half; femora black; anterior tibiae black; middle tibiae reddish on proximal half; posterior tibiae reddish on proximal three-fourths; abdomen dark brown pollinose above, cinereous pollinose laterally. Length, 7–8 mm.

Types.—Described from two females, Tuscon, Arizona (August); holotype in the American Museum of Natural History.

A male is at hand from Cobabi Mts., Arizona (September), and is quite similar to the female.

Cophura lutzi Curran

1931. *Cophura lutzi* Curran, Amer. Mus. Nov., 487: 7.
1934. *Cophura lutzi* Bromley, Ann. Ent. Soc. Amer., 27: 102.
1935. *Buckellia lutzi* Pritchard, Amer. Mus. Nov., 813: 7.
1941. *Cophura lutzi* James, Jour. Kans. Ent. Soc., 14: 33.

Cinereous and brown pollinose; two or three pairs of marginal scutellars; wings hyaline or tinged with brown; femora black; anterior four tibiae yellowish on proximal three-fourths; posterior tibiae yellowish on proximal two-thirds; abdomen cinereous pollinose dorsally, with a faint brownish tinge. Genitalia black. Length, 7.5 mm.

Types.—Described from a single male, Regnier, Colorado (August); in the American Museum of Natural History.

The diagnosis of *lutzi* is taken from the type. The third pair of scutellars are weakly developed. Material examined includes three males, four females, Hidalgo Co. and Weslaco Co., Texas (June); four females, Mountain Park and Alamorgordo, New Mexico (June); and one female, Kits Peak, Rincon, Baboquivari Mts., Arizona (Aug. 1–4). These specimens compare well with the type, although the New Mexico specimens have the tibiae more extensively blackened. One male, Chinati Mts., Texas, and one male, Otero Co., New Mexico (June), have the abdomen rich brown pollinose above; these may represent a new species.

Cophura lutzi var. **wilcoxi** (Pritchard)

1935. *Buckellia wilcoxi* Pritchard, Amer. Mus. Nov., 813: 8.

Cinereous and light brown pollinose; two or three pairs of marginal scutellars; wings hyaline or tinged with brown; anterior four tibiae yellowish on proximal three-fourths, posterior tibiae yellowish on proximal half; abdomen cinereous with brown fasciae. Length, 8–9 mm.

Types.—Male and female, Kenton, Oklahoma (June), in the American Museum of Natural History.

Additional material is necessary to show whether this form merits recognition or not.

BREVICORNIS GROUP

Differs from the FUR GROUP by having the face well rounded, receding orally, and from all the groups by having the mesonotum clothed with very short bristles and the abdomen finely punctate. The species all agree in having the body black, and the abdominal tergum with anterior margin and caudo-lateral angles white pollinose.

Cophura brevicornis (Williston)

1884. *Taracticus brevicornis* Williston, Trans. Amer. Ent. Soc., 11: 22.
1885. *Aphamartania brevicornis* Williston, Trans. Amer. Ent. Soc., 12: 54.
1909. *?Cophura brevicornis* Back, Trans. Amer. Ent. Soc., 35: 380.
1923. *Cophura brevicornis* Melander, Psyche, 30: 210.
1941. *Buckellia brevicornis* James, Trans. Kans. Ent. Soc., 14: 33.

Types.—Described from one male and one female, Washington Territory; at the University of Kansas.

One male, Manitou Park, Colorado (F. H. Snow), in the University of Kansas collection incorrectly bears a red label similar to the types. Material studied from Washington was from the following localities: Virden (July); Knightmore (Aug.); Wolf Fork, Touchet River (July); Tacoma (August); Puyallup (July, August); Rainier National Forest (July); Quilcene (Aug.); Wawawai (July). Material studied from Oregon was from the following localities: LaGrande (July); Cascadi (August); Newport (Sept. 7); Hood River; Strawberry Mtn., Grant Co., elev. 8,600 ft. (Aug.). One male was collected at Smith River, California (July). Colorado material was collected at Boulder (July). One male was taken at Monroe Canon, Sioux Co., Nebraska. All thirty-three of these specimens agree in having the legs castaneous.

Cophura brevicornis var. **melanochaeta** Melander

1923. *Cophura melanochaeta* Melander, Psyche, 30: 210.

Differs from ***brevicornis*** only in having the legs black.

Types.—Described from one pair, Waha, Idaho (August), and one female Moscow Mt., Idaho (July), probably in Dr. A. L. Melander's collection.

Material examined includes one female, Hamilton, Montana (July); two males, one female, San Antonio Canyons, California (Aug.). These specimens have the legs black. One female, Bishop, California (July), has the legs black, but the abdomen is dark reddish. Three males, two females, Laguna Mts., California (July), have the femora black to dark brownish, the tibiae dark chestnut to castaneous. One male, Lake Tahoe, California (July), has the legs dark castaneous, the fore femora blackish, and might well represent either ***melanochaeta*** or ***brevicornis***. It is quite likely that ***melanochaeta*** is not worthy of recognition.

Cophura caca, new species

Black; with cinereous pollinose markings. Legs black; abdomen with anterior line above and caudo-lateral spots on each segment whitish pollinose. Length, 8–10 mm.

Male.—Head cinereous pollinose. Face evenly convex, as seen from the side, projecting beyond the eyes by a distance as long as

first antennal segment. Mystax composed of several mixed rows of oral black bristles and a few white hairs on lower half of face. Bristles of ocellar tubercle, front, and proximal two antennal segments all black. First antennal segment with two bristles below equal in length to that below second; second segment two-thirds length of first; third not quite two and one-half times length of basal two combined; style as long as first antennal segment. Thoracic pleura cinereous pollinose; metapleura with bristles all white. Mesonotum with lateral and geminate middorsal stripes bare, with transverse aciculations; light cinereous pollinose around disc; clothed with stout black setae and five lateral bristles on each side; dorsocentrals undifferentiated. Scutellum with transverse impression near base; covered except on broad caudal margin with cinereous pollen; with several very small marginal setae. Legs jet black; femora transversely striate, clothed with white appressed hairs and black bristles; the slender bristles below on anterior tibiae white; tarsi with vestiture black. Wings nearly hyaline, lightly washed with grayish-brown; r-m cross-vein at two-thirds length of discal cell; anal cell open. Abdomen black, punctate, with black setae in the puncta; lateral bristles of first abdominal segment all white; tergites two to five with anterior margin and caudo-lateral spots whitish pollinose. Genitalia concealed from above, with hairs mostly black.

Female.—Similar; with a pair of small marginal scutellars.

Holotype.—Male, Otero Co., New Mexico, June 20, elevation 8,000 ft. (E. M. & R. H. Painter); in the collection of Dr. R. H. Painter. *Allotype.*—Female, Otero Co., New Mexico, June 20 (E. M. & R. H. Painter); in the collection of Dr. R. H. Painter.

Paratype.—Four males, seven females, Otero Co., New Mexico, June 20 (E. M. & R. H. Painter).

Related to ***brevicornis*** from which species it may be distinguished by having the tibial hairs white and by being larger in size.

ALBOSETOSA GROUP

The face is decidedly and evenly convex, receding orally, a condition closely approximated in BREVICORNIS. Otherwise from this there is no good character which will separate this group from all other groups. The shining black abdomen, convex above, marked only with caudo-lateral cinereous pollinose spots on each segment is characteristic of the group. Williston, Cole, and Curran have remarked on the similarity of appearance of the species to some of those of the genus *Cyrtopogon* Loew.

Cophura scitula (Williston)

1884. *? Nicocles scitulus* Williston, Trans. Amer. Ent. Soc., 11: 19, pl. 2, figs. 1, 1a.
1885. *Aphamartania scitulus* Williston, Trans. Amer. Ent. Soc., 12: 54.
1901. *Cophura scitula* Williston, Biol. Centr.-Amer., Dipt. 1, suppl.: 314.
1909. *Cophura scitula* Back., Trans. Amer. Ent. Soc., 35: 382.
1923. *Cophura scitula* Melander, Psyche, 30: 210.

Types.—Described from a female from Washington Territory, which is at the University of Kansas.

Melander further lists the species from Portland, Oregon. A male and female, Smith River, Douglas Co., Oregon (Sept.); and a female, presumably from the Northwest (July), are referred to this species. The type is described as 5.5 mm. long, and has the cross-veins and furcations flavescent. The specimens at hand are 9–10 mm. long, and have all the veins broadly clouded with brown. More collecting is necessary to show the exact status of this and the following species with regard to variation and synonymy. There is no character of value in the color of the mystax as used in the keys by Melander and Curran.

Cophura albosetosa Hine

1908. *Cophura albosetosa* Hine, Canad. Ent., 40: 202.
1919. *Cophura cyrtopogona* Cole, Proc. Calif. Acad., 9: 236.
1923. *Cophura albosetosa* Melander, Psyche, 30: 209.
1925. *Buckellia albosetosa* Curran, Canad. Ent., 57: 156.

Types.—Of *albosetosa*, two males, one female, Hope Mts., B. C. (July), and one female, Similkameen, B. C. (July), probably at the Ohio State Museum; of *cyrtopogona*, one male and one female, Hood River Valley, Oregon (August), in the California Academy of Sciences.

Albosetosa was described as being 7–9 mm. long, and as having the wings "uniformly very dilute brownish, so dilute, in fact, that they might well be said to be hyaline." *Cyrtopogona* was described as being 6 mm. long, with hyaline wings. Melander further listed *albosetosa* from Yakima, Washington, considering *cyrtopogona* to be a synonym. A male, Mt. Rainier, Washington (Sept.); a male Merritt, B. C. (Aug.); and a female, Mt. Rainier, Washington (July), are referred to this species. These specimens are 7–8 mm. long, with the wings hyaline in the female; costal cell brown and veins proximally bordered with brown in the male. Curran recorded *albosetosa* from Revelstoke, B. C.

Cophura vitripennis (Curran)

1927. *Buckellia vitripennis* Curran, Canad. Ent., 59: 85.

Types.—Male, Lillooet, B. C. (June), in the Canadian National Collection. Known only from the type specimen.

The key and group characters should serve for easy recognition of this species.

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A REVISION OF THE NORTH AMERICAN SPECIES OF BUPRESTID BEETLES BELONGING TO THE TRIBE CHRYSOBOTHRINI, by W. S. FISHER. 1942. Pages 275; 109 text figures and 17 plates. Published by U. S. Dept. Agri., Misc. Pub. 470.

This revision of the North American *Actenodes* and *Chrysobothris* is quite welcome.

Since Horn's monograph of the latter genus in 1886, many new species have been described. The author has straightened out the confusion which existed in regard to names and seven new species are described. Four distinct species are recognized in the *Chrysobothris femorata* complex. It is possible that past records of degrees of damage caused by the flatheaded apple tree borer in various parts of the country may now be accounted for.

Keys are given for both males and females as far as material permitted. All species are completely described and character differences in sexes are noted. Wherever possible descriptions are drawn from type specimens. Both surfaces of the male genitalia as well as last visible sternites of both sexes, clypei and anterior tibiae of the males are figured.

This complete, well illustrated paper will be a great aid to those of us working on Coleoptera.—J. N. KNULL.

THE AMERICAN SPECIES OF RHOPALOSOMA

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The genus Rhopalosoma was first described by Cresson in 1865 with a Cuban species, *R. poeyi* as the genotype. Cresson regarded it as an aberrant member of the Ichneumonidae. Several years later, in 1868, Westwood published an account of a similar insect from Hayti to which he gave the name *Sibyllina aenigmatica*, placing it among the aculeate Hymenoptera and suggesting that it is related to the Vespidae although not dissimilar to certain Sphecidae (Pelopoeus), and in the male even resembling an ant. In his "Thesaurus Entomologicus Oxoniensis" Westwood later (1874) gives a much fuller account of his views on the relationships of Rhopalosoma which he then recognized as a prior name for his own genus Sibyllina. He refers there also to the views of Cresson and Frederick Smith (1868) who agreed that it was related to the Ichneumonidae. He notes that the late Mr. Haliday had earlier attached to the type specimen a note that he regarded it as related to Pelopaeus. I shall not repeat the several arguments indulged in by these earlier entomologists, as they are reviewed by Westwood (1874).

The question of the systematic affinities of Rhopalosoma was reopened in 1896 by Ashmead who again discussed at length the views of his predecessors. He further proposed the elevation of Rhopalosoma to family rank and placed it as a true aculeate and "a connecting link between the Vespidae and Sapygidae." In his later classification of the Vespoidea (1903) Ashmead placed his family Rhopalosomidae Vespoidea in the linear arrangement[1] after the Scoliidae, Tiphiidae and Cosilidae and before the Thynnidae, Myrmosidae and Mutillidae.

In 1910 Morley described a Rhopalosomatid from India and took occasion to review the matter. He differed with Ashmead as he saw no close relationship of Rhopalosoma to the Cosilidae and Thynnidae.

After the lapse of another period of years, Turner and Waterston (1917) reviewed the matter in connection with the neotropical genus Olixon of Cameron which they regarded as related to Rhopalosoma, placing both in the vicinity of the Vespidae or Eumenidae as had been done by Westwood. They add also that the genitalia of the male indicates close affinities with the Eumenidae which in turn differ strongly in this respect from all other Hymenoptera. Unfortunately they go no further as to the peculiarities of the Eumenidae and Rhopalosomatidae and Dr. Joseph Bequaert assures me that he does not consider the Eumenidae and Vespidae to have unusual male genitalic structures after many years of intensive study of these wasps.

The most prominent structures of the male genitalia of Rhopalosoma are a pair of upcurved spines which occasionally project beyond the

[1]The correctly formed family name, Rhopalosomatidae, has been used by most recent workers and should replace the contracted spelling which is not in accordance with any accepted code of nomenclature.

tip of the abdomen. These seem never to have been mentioned in the literature, probably because they are most frequently retracted within the body. When fully exserted as in one specimen before me, they are similar in form and curvature to those characteristic of the Mutillidae. They are also apparently identical with a pair that are present in the African genus, Algoella,[2] and in the Australian Harpagocryptus mentioned in the following paragraph, and in Olixon.

The present writer has referred to Olixon in two earlier papers (Brues, 1922 and 1926) and could not accept the views expressed by Turner and Waterston concerning its affinities with Rhopalosoma. His opinion might, however, possibly require revision in view of the similarly bispinose hypopygium in these two genera and the strangely similar habits of Rhopalosoma and Harpagocryptus which is obviously a relative of Olixon. Thus, in 1913, Hood reared Rhopalosoma from a larva which was parasitic externally on a species of true cricket (*Orocharis saltater*) after the manner of members of the family Dryinidae. Moreover, in the Australian Harpagocryptus the larva likewise forms an external sac on the side of the abdomen of crickets. Such similarities are most remarkable and cannot be disregarded in any attempt to place Rhopalosoma in the system.[3] Unfortunately Olixon, Harpagocryptus, Algoella, and Nealgoa, although obviously related among themselves, form a group of very different affinities that cannot be associated with the Dryinidae.[4]

Thus, we must still accept Rhopalosoma as a highly aberrant hymenopteron, forming the type of a family whose relationships cannot be determined with certainty. The African Paniscomima Enderlein is probably not generically distinct as its separation rests upon very slight

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[2]This insect was described by the writer in 1910 as Algoa, but as the generic name is preoccupied, Kieffer proposed Algoella as a substitute in 1914 (Das Tierreich, Lief. 41, p. 000). However, I strongly suspect that the wasp described by Cameron as *Apteropompilus dentatus* from Cape Colony (Zeits. Hym. u. Dipt., 1904, p. 176, ♀, and 1905, p. 136, ♂) is *Algoella heterodoxa* Brues. Cameron's description of the greatly thickened fore legs, the wingless male, the long pronotum and the dentate propodeum make it probable that the insect before him was congeneric and so far as it goes, the description agrees with *A. heterodoxa*, even to the color of the species in question. If they are identical, Cameron's specific name has priority.

[3]It is well known that the females of most Dryinidae have the front tarsi greatly modified to form grasping organs that presumably enable them to keep in contact with their very active hosts at the time of oviposition. It seems probable that the strangely inflated tarsi of the female Rhopalosomatidae have the same function, but they can in no sense be traced to a common stem as their origin and development is obviously independent. Thus their similar function and dissimilar structure seem to weigh against any association of the two families as closely related.

[4]Still another view, and probably the correct one, has recently been put forth by Reid (1939), who places Olixon in the Psammocharidae together with Algoella, Harpagocryptus, Olixon, Nealgoa. He believes that Algoella is very close to *Phyllosphex* (*Apteropompilus*) *dentatus* Cameron, a conclusion that I can heartily support, as noted in a preceding paragraph. There still remains the question of the strangely similar parasitic habits of Rhopalosoma, Dryinus *et al.*, and Harpagocryptus, and it is difficult to cast these aside as purely fortuitous or convergent developments. There seems to be no evidence that any of the other wingless Psammocharidae depart from the general habit of their relatives in preying on spiders (*cf.* Arnold, 1940).

characters. The Indian Hymenochimaena based on ***Rhopalosoma abnorme*** Morley is unquestionably a true Rhopalosomatid, very distinct from Rhopalosoma and perhaps the future discovery of other forms related to it may serve to clarify the systematic relationships of this very remarkable group.

The material on which the following taxonomic account is based is not large, as the insects appear never to be abundant. It includes specimens belonging to the Museum of Comparative Zoology, United States National Museum, Cornell University, the Carnegie Museum at Pittsburgh and some in my own collection. Including the single specimen of ***Rhopalosoma poeyi*** Cresson now preserved in the Philadelphia Academy of Sciences, I have been able to study in all 37 specimens from North America, the West Indies, Central American and South America. These represent five species, all closely related and distinguishable by slight, although I believe, sufficiently distinctive characters to warrant their separation.

Rhopalosoma Cresson

1865. Cresson, Proc. Entom. Soc. Philadelphia, vol. 54, p. 58.
1868. Westwood, Trans. Entom. Soc. London, p. 329 (*Sibyllina*).
1874. Westwood, Thesaurus Entom. Oxon., p. 130.
1896. Ashmead, Proc. Entom. Soc. Washington, vol. 3, p. 303.
1910. Morley, Trans. London Entom. Soc., 1910, p. 386.
1926. Brues, Psyche, vol. 33, p. 19.

KEY TO THE SPECIES OF RHOPALOSOMA

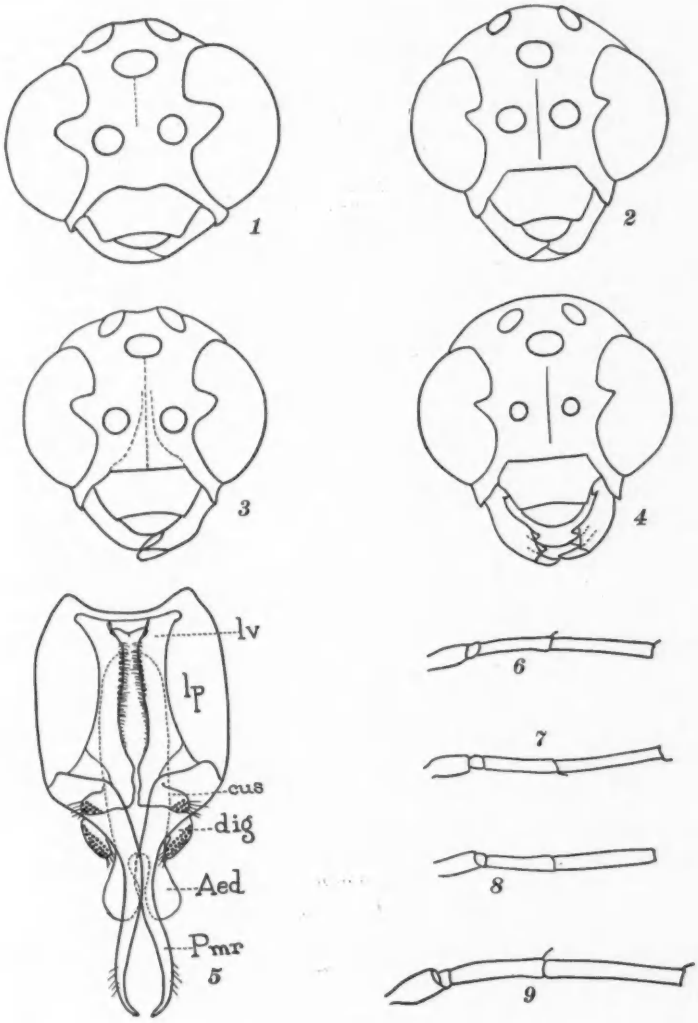
1. Eye-notch very large, approximately as deep as the width of the antennal scape (fig. 1); median ocellus wider than the distance that separates it from the eye-margin ..... **aenigmaticum**
   Eye-notch of moderate or small size, not deeper than the width of the first flagellar joint (figs. 2, 3, and 4); median ocellus separated from the eye-margin by at least its own width 2
2. Flagellum of antennae entirely pale ferruginous or fulvous, concolorous with the body 3
   Flagellum of antennae darker, entirely black above 4
3. Eye-notch of moderate size (as in fig. 3) ..... **poeyi**
   Eye-notch small (fig. 2) ..... **nearcticum**
4. Eye-notch of moderate size (fig. 3) ..... **bolivianum**
   Eye-notch small (fig. 4) ..... **simile**

The species of Rhopalosoma are all rather large, wasp-like insects of pale brownish color with long, slender legs and large hyaline wings.

EXPLANATION OF PLATE I

Fig. 1. Head of *Rhopalosoma aenigmaticum* Westw., frontal view, with antennae not shown. 2. Head of *Rhopalosoma nearcticum* sp. nov. 3. Head of *Rhopalosoma boliviense* sp. nov. 4. Head of *Rhopalosoma simile* sp. nov. 5. Male genitalia of *Rhopalosoma nearcticum* in dorsal view. Aed., aedeagus; cus., cuspis volsellaris; dig., digitus volsellaris; lp., lamina parameralis; lv., lamina vosellaris; Pmr., paramera. 6. Basal segments of antenna of *Rhopalosoma aenigmaticum*. 7. Basal segments of antenna of *Rhopalosoma nearcticum*. 8. Basal segments of antenna of *Rhopalosoma bolivianum*. 9. Basal segments of antenna of *Rhopalosoma simile*.

The figures are from camera lucida drawings made by Mrs. A. S. O'Connor.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The head is more or less lenticular, about twice as wide as long in vertical view and about as high as wide in frontal view. Eyes moderately large, very strongly convex and with their inner margin deeply emarginate next to the insertion of the antennae. Ocelli very large in both sexes. Clypeus large, broad, convex, its anterior margin straight; deeply separated from the front. Labrum triangular, twice as broad as long. Mandibles large and strong, armed with three teeth at apex, the inner tooth smallest and the outer one much the largest. Maxillary palpi much longer than the head; basal segment short, second longer, swollen; third and fourth longer, growing much more slender; fifth longest, very thin. Antennae long and slender, slightly geniculate; scape short and thick; pedicel very small, transverse; segments of flagellum cylindrical, each bearing a pair of short, thin spines at apex; first segment much the shortest; second and following about equal, the segments becoming extremely slender toward the tip of the antennae. Male with 13 and female with 12 antennal segments. Thorax slender, posterior angles of pronotum reaching to the tegulae; mesonotum as broad as long, with parallel parapsidal furrows that are complete behind, but do not extend to the anterior border of the mesonotum. Propodeum long, smooth, gradually declivous behind, the abdomen attached to its tip just beyond the insertion of the hind coxae. Legs long and slender; anterior femora strongly thickened basally in the female, in which sex the second to fourth tarsal segments are greatly flattened, expanded laterally and trifid apically with the projections connected by a thin, transparent membrane, Tarsi of male very slender, simple. Tarsal claws of female long, stout, sharply hooked at the tip and with a small subapical tooth; the claws bear also a number of stout, bristly hairs. Tarsal claws of male similar, but minute and more slender. The trochanters appear to be two-segmented, but the second segment is really a part of the femur rather than of the trochanter as it is anchylosed with the former at least in the hind legs. Wing venation rather unusual. Fore wing with no costal cell; stigma narrow, linear; radial cell long and narrow; basal vein long and sloping, almost parallel with the long first recurrent nervure; basal two sections of cubitus very thin and delicate as are also the transverse cubiti, the cubitus arising well below the base of the basal vein; second recurrent nervure very faintly indicated, nearly interstitial with the second transverse cubitus; nervulus strongly postfurcal; first discoidal cell very large, fully five times as long as high. Hind wing with a double anal lobe formed by two deep incisions; radiellan cell broad externally. Abdomen with a long cylindrical petiole, which is very slender at the base and gradually swollen near apex, its spiracles placed just before the middle; second tergite long, third shorter, fourth very short, fifth and sixth longer. Sting terminal; male with a pair of slender, upcurved spines at the tip of the abdomen, which are not always extruded.

Rhopalosoma aenigmaticum Westwood

1868. Westwood, Trans. Entom. Soc. London, p. 329 (*Sibyllina*).
1874. Westwood, Thesaur. Entom. Oxon., p. 130, Pl. 24, fig. 9.

Female.—Length 11 mm. Pale testaceous or luteous, without any distinct darker markings or stains, except the area between the ocelli and tips of the mandibles which are black; antennae entirely pale. Ocelli very large, the width of the median ocellus clearly greater than its distance from the eye-margin or from the posterior ocelli. Emargination of inner margin of eye very large and deep, its depth equal to the greatest thickness of the scape of the antennae; its inner margin rounded, not at all angulate. Head in dorsal view twice as wide as long, the occiput rather feebly and weakly narrowed medially; in frontal view the head is seven-eighths as high as wide, measuring from the vertex to the lower margin of the clypeus. Upper portions of head entirely smooth, but not at all highly polished. Sides of face below very faintly pilose, clypeus distinctly so, with a fringe of long hairs along its anterior margin; the labrum densely pilose. Second flagellar segment one-half longer than the first; third equal to the second; following segments gradually but very slightly shorter and much more slender toward the tip of the antennae. Thorax clothed with very short but quite dense pile. Parapsidal furrows narrow, but sharply defined, not extending in front of the anterior third of the mesonotum. Petiole of abdomen slightly less than five times as long as high at its thickest portion where it is as wide as high.

Male.—Somewhat smaller and more slender, but essentially similar.

The description given above is drawn up from a single male and female from Manneville, Hayti, collected by Dr. William M. Mann.

Another pair from the same locality collected during February, 1922, are in the collection of the American Museum of Natural History. The male is very small (8 mm.), and is apparently a depauperate specimen with the ocelli abnormally small.

I have assumed that these specimens are conspecific with Westwood's types which were from Hayti, although it has been impossible to compare them. Naturally Westwood thought the Haytian form was identical with Cresson's species from Cuba as there was no reason to believe that Rhopalosoma included more than a single species.

Rhopalosoma poeyi Cresson

1865. Cresson, Proc. Entom. Soc. Philadelphia, vol. 4, p. 59.

I have examined a single female from the series of three females and two males that were used by Cresson for his original description. This is in the collection of the Philadelphia Academy and is apparently the only example of the type series remaining. It is very similar to the other species, but I think definitely distinct on the basis of the characters cited in the foregoing key. Apparently it has not been collected since its original discovery in Cuba by Gundlach, and like the other members of the genus, appears to be a rare insect.

Rhopalosoma nearcticum sp. nov.

Female.—Length 13.5–17.0 mm. Color pale fulvo-ferruginous, the space between the ocelli and the tips of the mandibles blackened; antennae not darkened on the flagellum; abdomen rarely slightly darker toward the apex. Width of median ocellus very distinctly less than the distance that separates it from the eye margin and about equal to its distance from either of the posterior ocelli. Emargination of inner margin of eye comparatively small, more triangulate and angular than usual. Head in dorsal view twice as wide as long, the occiput sharply narrowed medially; in frontal view seven-ninths as high as wide, measuring from the vertex to the lower margin of the clypeus. Upper parts of head practically bare and impunctate; sides of face below pilose with very minute hairs; the lower margin of the clypeus fringed with much longer fulvous hairs; labrum densely clothed with similar hairs. Antennae showing no distinctive specific characters. Second flagellar segment one-half longer than the first, or barely less; second and third equal, each slightly but distinctly longer than the fourth; following segments growing gradually shorter and more slender to the tip of the antenna which is extremely thin. Pilosity of thorax very short and sparse, white, visible only in certain lights. Parapsidal furrows very clearly impressed, narrow, smooth, slightly bowed outwards at the middle and not extending in front of the anterior fourth of the mesonotum. Petiole of abdomen slightly more than five times as long as high at its thickest portion where it is as wide as high.

Type ♀ from Kissimmee, Florida, (Nathan Banks Collection), in the Museum of Comparative Zoology. I have seen also numerous specimens of both sexes, all from various parts of Florida, as indicated below; Seminole Co., Fla., June 9–July 18, 1929 (M. M. Brunk, H. Clark, B. D. Hiers, Jr., C. Nelson); Hillsboro Co., Fla., June 16 (M. M. Brunk); Orange Co., Fla., July 7–16, 1929 (B. L. Smith and E. Storrs); all of these in the U. S. National Museum; Fort Mead, Fla., August 13, 1920 (P. W. Oman), in the University of Kansas Museum; Gulfport, Fla., June (Reynolds), in the Museum of Comparative Zoloogy and the Cornell University Museum; Plummer's Island, Md. (J. D. Hood); Berlin, Md. (F. C. Bishopp); and St. Augustine, Fla. (Ashmead Collection), in the U. S. National Museum. Other records of Rhopalosoma from the Southeastern states as far north as Washington undoubtedly refer to this species.

Rhopalosoma bolivianum sp. nov.

Female.—Length 16 mm. Fulvo-ferruginous; the head paler and the apical portion of the abdomen darker apically, the last segment dark brown. Flagellum of antennae entirely black, except for the under side of the first segment at its base; space between the ocelli dark brown. Width of median ocellus one third less than its distance from the eye-margin, about equal to its distance from the posterior ocelli. Emargination of inner eye-margin moderately large and deep, acutely rounded at the bottom; its depth much less than the

thickness of the scape and about equal to the thickness of the first flagellar segment. Head in dorsal view almost twice as wide as long; seven eighths as high as wide in frontal view, measuring from the vertex to the lower margin of the clypeus. Surface of head above smooth and slightly shining; face below and clypeus weakly pilose, the hairs longer on the labrum, but quite sparse. Second flagellar segment one half longer than the first; third as long as the second. Thorax very sparsely clothed with very short pile; parapsidal furrows not extending in front of the anterior fourth of the mesonotum, narrow and very sharply defined. Petiole of abdomen not quite four times as long as high at its thickest portion where it is slightly narrower than high.

Type from Buena Vista, near Santa Cruz, Bolivia, J. Steinbach, 1928, in the Cornell University Collection.

Rhopalosoma simile sp. nov.

Female.—Length 18–20 mm. Fulvo-ferruginous, the abdomen more or less stained with brown above beyond the second tergite; space between the ocelli black; antennae flagellum entirely black, width of median ocellus equal to its distance from the posterior ocelli. Emargination on inner margin of eye comparatively small, less than the thickness of the first segment of the antennal flagellum, nearly triangular in shape with the inner edge of the excavation very sharply rounded, almost pointed at the bottom. Head in dorsal view almost twice as wide as long; four-fifths as wide as high in frontal view, measuring from the vertex to the lower margin of the clypeus. Head smooth and rather strongly shining above, the face noticeably pilose; the labrum with dense, much longer hairs. Second flagellar segment slightly more than one and one half times as long as the first, subequal to the third. Thorax very weakly pilose. Parapsidal furrows deeper and wider than usual, especially anteriorly, not extending forward of the anterior third of the mesonotum. Petiole of abdomen clearly less than four times (375 : 100) as long as high at its thickest portion where it is as wide as high.

Male.—Length 13–14 mm. Considerably more slender and smaller than the female, but otherwise essentially similar, except for the secondary sexual characters. Darkened area between ocelli extended laterally almost to the eye-margin. In one male from Tuis, Costa Rica the eye-notch is deeper, but the head is asymetrical and the specimen is apparently abnormal, although obviously not a gynandromorph.

Type female from Barro Colorado Island, Canal Zone, May 10–12, 1926 (C. T. Greene), in the U. S. National Museum. Paratypes: San Rafael Cumanacoa, Sucre, Venezuela, Nov. 8, 1929 (G. Netting), in the Carnegie Museum at Pittsburgh; Sixola River, Costa Rica (William Schaus), in the U. S. National Museum; Trinidad River, Panama, May 7, 1911 (August Busck), in the U. S. National Museum; Cayuga, Quatemala, May, 1915 (William Schaus), in the U. S. National Musuem. Males from Trinidad River, Panama, May 8, 1911 (William Schaus),

and Tuis, Costa Rica, 2400 ft. (C. H. Lancaster), both in the U. S. National Museum. Five additional females were later loaned by the U. S. National Museum; four of these were collected by James Zetek at Barro Colorado, C. Z., and the other at Quirigua, Quatemala, by Wm. Schaus.

The type specimen bears a label indicating that it was taken at light, behavior which might be expected on account of the very large ocelli.

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A HUNDRED NEW SPECIES OF AMERICAN SPIDERS, by RALPH V. CHAMBERLIN and WILTON IVIE. Published as Vol. 32, No. 13. Bull. Univ. of Utah, pp. 117, 17 pls. which carry 230 figs. 1942. Paper bound. University of Utah, Salt Lake City, Utah.

Two excellencies appear in this publication. (1) Species descriptions have not been broadcast of many short papers in various journals. (2) The illustrations by Ivie are among the best that appear in entomological publications.

Chamberlin and Ivie among others are showing us what a rich spider fauna we have in North America. For carnivores it is remarkably large and complex. But then we do have the many insects which are not yet rationed to the spiders.

—C. H. K.

THE LARVAE OF THE ARMY ANTS

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Army ants are among the most notorious insects of the tropics. They have been written about by travelers and studied by entomologists for more than a century. But their larvae, by contrast, are seldom seen and have received comparatively scant attention even from myrmecologists.

Army ants belong to the Subfamily Dorylinae. The most conspicuous genera are Dorylus in the Old World tropics and Eciton in the Neotropical and southern Nearctic Realms. Less common is the Old World Aenictus. Cheliomyrmex is found only in the warmest parts of the Neotropical and is only locally abundant. The African Aenictogiton is known only from males. The genus Leptanilloides is known only from a few workers of the type species collected in Bolivia and its position in the Dorylinae is uncertain. Leptanilla, formerly regarded as a doryline, is now placed in a separate subfamily.

In this paper the larvae of thirteen species in four genera have been described. In addition I have included all the references to doryline larvae that I have been able to find in the literature.

Subfamily **Dorylinae** Leach

Larvae elongate, slender, subcylindrical; with a slight progressive attenuation toward the anterior end; nearly straight but with the anterior end slightly curved ventrally; orthocephalic.[1] Twelve or thirteen distinct somites. Spiracles minute. Vestigial legs relatively large and conspicuous. Hairs short; sparse to moderately abundant; mostly simple (but branched or plumose in Acamatus). Head large, with short simple hairs. Antennae with two sensilla each. Mandibles poorly developed; of two types—elongate, slender, slightly curved and denticulate, or short, small, acuminate and feebly sclerotized. Maxillary palps wanting or represented by a more or less elevated group of sensilla. Trophorhinium[2] poorly developed or absent.

Wheeler (1922, p. 39) describes the larvae of the Dorylinae as "more or less cylindrical, with short hairs, without hooked setae; mandibles small, slender, falcate." Forel, 1928, Vol. I, p. 131 = 1921, Tome 1, p. 136: "More or less cylindrical, with short hairs and no hooked hairs" ("plus ou moins cylindriques, à poils courts, sans poils d'accrochage").

Emery (1904, p. 115) describes the doryline type as having a "forma sottile, quasi cilíndrica."

Gallardo, 1920, p. 309: "Larvas más o menos cilíndricas, con pelos cortos, sin pelos para engancharse."

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[1] *Orthocephalic*, having the head at the anterior end of the body, in contrast with *hypocephalic*, having the head apparently on the ventral surface near the anterior end.

[2] *Trophorhinium*, a term applied by Wheeler (1920, p. 257) to the aggregate of roughened surfaces of the mouth parts which might be used in triturating food.

"The less independent larvae of the Dorylinae receive from their ☿ balls of food prepared beforehand from the prey." Forel, 1928, Vol. I, p. 516=1922, Tome 3, p. 136: "Moins indépendantes, les larves des Dorylinae reçoivent de leurs ☿ des boulettes alimentaires toutes préparées faites avec des proies." Additional notes from Wheeler and Bailey on feeding may be found below under Eciton.

Wheeler found the larvae of the Dorylinae and those of the Cerapachyinae to be extremely alike. "The mandibles are small, narrow, pointed and rather feebly chitinized, and I have failed to find a trophorhinium in either group. Apparently the young are fed only on soft food." (1920, p. 50).

KEY TO THE GENERA OF DORYLINE LARVAE

1. Body relatively enormous; anterior end bent ventrally at an angle of 90°; terminal somite a very slender conical "tail" ..... ♂ of **Dorylus**
   Not as above 2
2. Maxillary palp represented only by scattered sensilla ..... **Dorylus (Anomma)**
   Maxillary palp, a conspicuous, compact group of sensilla, which is more or less elevated 3
3. Integument of body with neither spinules nor papillae ..... **Aenictus**
   Integument with numerous minute spinules or papillae arranged in rows 4
4. Integument papillose ..... **Eciton** *s. str.* and **E. (Labidus)**
   Integument spinulose 5
5. With only simple hairs on the body ..... **Cheliomyrmex**
   With both simple and branched hairs on the body ..... **Eciton (Acamatus)**

Tribe **Cheliomyrmicini** Wheeler

Genus **Cheliomyrmex** Mayr

Body hairs sparse, short, simple, flexuous. Integument spinulose. Head hairs numerous. Mandibles small, simple, acuminate, sharp-pointed, feebly sclerotized. Maxillary palp represented by a large convex, elliptical area bearing 11–15 sensilla.

C. megalonyx Wheeler.—Figs. 14–18. Moderately stout; orthocephalic; pro- and mesothorax slightly inclined ventrally forming an angle with the rest of the body, which is straight; thickest at the fourth abdominal somite, somewhat attenuated toward either end; posterior end bluntly pointed; anus subterminal; vestigial legs large rounded elevations. Minute vestigial gonopods on the seventh, eighth, and ninth abdominal somites. Twelve distinct body segments. Body rather sparsely clothed with simple flexuous hairs about 0.1 mm. long, arranged in bands around the middle of each segment; the anterior and posterior margins of each segment naked, except on the terminal segment where the hairs are uniformly distributed. Integument of body (but not of head) roughened with short transverse rows of exceedingly minute spinules, 3–6 in each row. Head large, cranium in anterior view subtrapezoidal, a trifle broader than long, broadest just above the level of the antennae; posterior angles broadly rounded. Head beset with numerous short (about 0.04 mm.) simple hairs. Antennae situated quite low on the cranium; each with two sensilla. Labrum small, transverse, twice as broad as long, appearing in profile as a short thick flap with the free edge rounded; the dorsal

surface bearing several short hairs, the ventral spinules in short arcuate rows. Mandibles small, simple and feebly sclerotized; basal half dilated; apical half acuminate. Maxillae large, subtriangular in anterior view, bearing a few small hairs; palp represented by an elevated elliptical area bearing 11–15 sensilla; galea a small papilla bearing two apical sensilla. Labium with the free end broadly rounded; palp represented by a minute circular elevation bearing four or five sensilla, and a single isolated sensillum nearby. Trophorhinium consisting only of the spinules on the ventral surface of the labrum. (Material studied: numerous specimens from British Guiana.)

In a recent paper (1938, p. 140) I have referred to the vestigial legs of this same species.

Text Figure 1. Male larva of *Dorylus* (*Anomma*) *wilverthi* Emery, photographed beside a centimeter scale. ×1½.

Tribe **Dorylini** Forel

Genus **Dorylus** Fabricius

Body hairs sparse, short, simple, flexuous. Integument without spinules or papillae. Head hairs few. Mandibles small, simple, acuminate, sharp-pointed, feebly sclerotized. Maxillae and labium inflated; typical palps and galeae lacking; numerous sensilla scattered over the surfaces.

Forel (1928, Vol. II, p. 298=1923, Tome 5, p. 116) states that the larvae of Dorylus (Anomma) "are much less nimble and more dependent upon the workers than those of the Ponerinae" ("bien moins ingambes et plus dépendantes des ☿ que celles des Ponerinae").

D. (**Anomma**) **wilverthi** Emery.—Figs. 1–6. Slender, subcylindrical, orthocephalic, nearly straight but with the anterior end somewhat attenuated. Thirteen distinct postcephalic somites, the prothorax being the longest. Anus terminal. Vestigial legs relatively large convex elevations. Body beset with a very few simple hairs.

Head large; in anterior view somewhat longer than broad, with the cranium subhexagonal and bearing four groups of sensilla and a few simple hairs about 0.09 mm. long. Antennae large and convex, each with two sensilla. Front bulging and convex. Labrum transverse, short, and very thick; narrowed distally, with the anterior angles rounded; anterior surface bearing eight hairs similar to those on the cranium; numerous sensilla on the distal surface and two on the posterior surface. Mandible small and feebly sclerotized, with the base slightly expanded and the apex slender, straight, and acute. Maxillae inflated and subglobular, furnished with a few simple hairs; palp represented by a loose cluster of 14–21 sensilla, one of which is mounted on a small projection; galea a short, rather stout papilla, apparently without sensilla. Labium with the prementum swollen, moderately large, and feebly impressed at the middle of the distal surface; postmentum inflated and sagging; palp represented by a diffuse cluster of sensilla, some of which bear a spinule; opening of sericteries a long transverse arcuate groove. Trophorhinium wanting. (Material studied: Four slightly damaged specimens from the Belgian Congo.)

A number of years ago I had the opportunity of photographing (Text fig. 1) a male larva of this species from the Belgian Congo, but was unable to obtain the specimen for further study. Apparently it is indistinguishable from the male of *D. molesta* described below.

There is a reference in my paper on vestigial legs (1938, p. 140) to the above species.

D. (Anomma) nigricans Illiger.—Forel (1912, Pl. I, fig. 6) has figured a semipupa.

D. (Anomma) nigricans var. **molesta** (Gerstäcker). *Male.*—Fig. 7. Size enormous (relative to worker); length of mid-dorsal line 47 mm.; maximum diameter (at 5th abdominal somite) 8.8 mm. Body moderately stout, subcircular in cross-section, tapering gradually toward the ends, which are both acute. Anterior portion, *i. e.*, first six somites, bent ventrally at an angle of 90 degrees. Thirteen distinct somites. Terminal somite having the shape of a slender cone—much more slender than the penultimate somite, into which it is partially retractile. Penultimate somite having a shape somewhat like the

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EXPLANATION OF PLATE I

Dorylus, *Aenictus*, and *Cheliomyrmex*

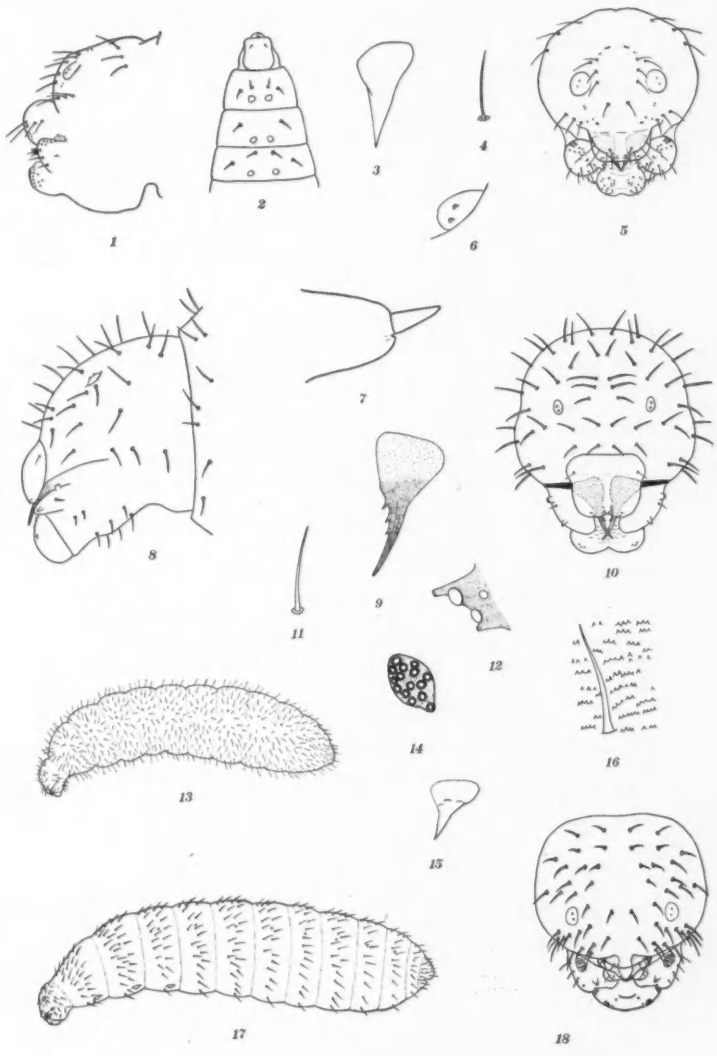
Dorylus (*Anomma*) *wilverthi* Emery, Figs. 1–6. 1, head in side view, × 53; 2, head and thorax in ventral view, × 17; 3, mandible in anterior view, × 133; 4, body hair, × 185; 5, head in anterior view, × 53; 6, antenna in side view, × 175.

Dorylus (*Anomma*) *nigricans* var. *molesta* (Gerstäcker), ♂. Fig. 7, last two somites in side view, × 4.

Aenictus (*Typhlatta*) *leviceps* (F. Smith), Figs 8–10. 8, head in side view, × 91; 9, mandible in anterior view, × 197; 10, head in anterior view, × 91.

Aenictus (*A.*) *aratus nesiotis* var. *fraterculus* Wheeler, Figs. 11–13. 11, body hair, × 253; 12, maxillary palp, × 333; 13, larva in side view, × 17.

Cheliomyrmex megalonyx Wheeler, Figs. 14–18. 14, maxillary palp, × 211; 15, mandible in anterior view, × 133; 16, body hair and integumentary spinules, × 181; 17, larva in side view, × 14; 18, head in anterior view, × 61.



frustrum of a cone; anus on the apical end beneath the base of the terminal somite. Spiracles exceedingly minute in porportion to body size. No hairs on body. Head relatively very small, the maximum breadth being only 0.6 mm. The head is, in fact, so small and delicate in proportion to the vast bulk of the body that it is easily broken off from preserved larvae, especially when shipped in vials with other specimens. Most of the larvae available to me have therefore been decapitated. On the basis of inadequate material, the head seems to be quite similar to that of the worker larva of *D. wilverthi*. (Material studied: several larvae collected in Kenya by G. van Someren and made available to me through the courtesy of Dr. N. A. Weber.)

D. (D.) affinis Shuckard.—Emery (1901) has figured (Pl. II) a ♀ semipupa in side view (fig. 1), head of same in side view (fig. 2), ventrolateral view of head (fig. 3), and mouth parts in side view (fig. 4). His description (p. 429) follows:

"Queste larve sono tutte bianchissime, subcilindriche, debolmente assottigliate in avanti, coi segmenti poco marcati. Sono fornite di peli piuttosto lunghi, ma semplici e poco numerosi, disposti in zone segmentali che si riducono a semplici serie trasversali sui segmenti posteriori del corpo. Il capo é piccolo, ritondato. Labbro superiore e mascelle sono ritondati, queste sono fornite di alcune papille non colorate né notevolmente sporgenti, ultimo rudimento forse delle due punte che offrono nelle larve delle Ponerine. Il labbro inferiore costituisce anch'esso una sporgenza rotonda, un poco incavata nel mezzo superiormente, ed é fornito di peli e di alcune piccole papille; nessun vestigio di filiera. Le mandibole sono molto piccole, acuminate, brune. Al disopra della bocca, il capo presenta un paio di piccole sporgenze lenticolari che credo debbansi considerare come rudimenti di antenne. Se si esamine una larva in cui le antenne dell'immagine siano giá formate, ma il capo non si sia ancora staccato dalla cuticola larvale, l'estremitá delle antenne corrisponde ai rudimenti anzidetti."

Tribe **Ecitonini** Forel

Body hairs moderately abundant; short, simple or branched. Head hairs simple. Mandibles elongate, slender, slightly curved, with the medial border denticulate.

EXPLANATION OF PLATE II

Eciton

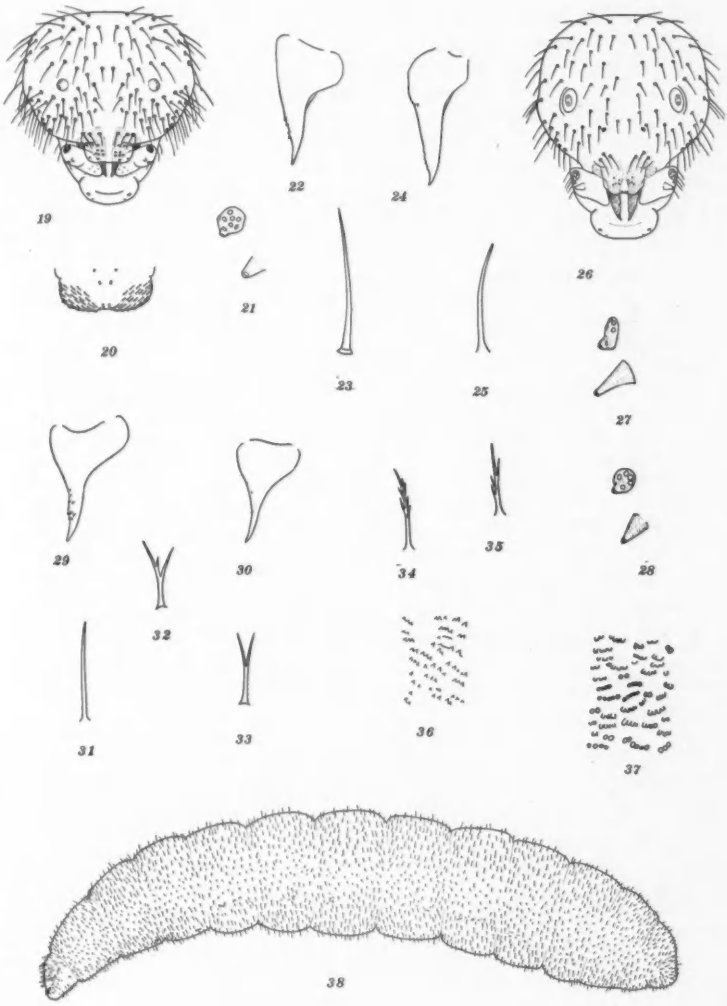
Eciton (*E.*) *hamatum* (Fabricius), Figs. 19–23 and 38. 19, head in anterior view, × 49; 20, labrum in posterior view, × 87; 21, maxillary palp and galea, × 167; 22, mandible in anterior view, × 108; 23, body hair, × 185; 38, larva in side view, × 12.

Eciton (*Labidus*) *coecum* (Latreille), Figs 24–28. 24, mandible in anterior view, × 153; 25, body hair, × 185; 26, head in anterior view, × 73; 27, maxillary palp and galea in profile, × 187; 28, maxillary palp and galea in face view, × 187.

Eciton (*Acamatus*) *schmitti* Emery, Figs 29–33. 29, mandible of ♂ in anterior view, × 83; 30, mandible of ♀ in anterior view, × 167; 31–33, body hairs, × 185.

Eciton (*Acamatus*) *pilosum* F. Smith, Figs. 34–36. 34–35, body hairs, × 185; 36, integumentary spinules, × 185.

Eciton (*E.*) *burchelli* (Westwood), Fig. 37, integumentary papillae, × 181.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Genus **Aenictus** Shuckard

Body hairs simple. Integument without spinules or papillae. Hairs of head few. Labrum large and conspicuous. Maxillary palp represented by three subconical sensilla fused into an irregular projection.

A. (Typhlatta) leviceps (F. Smith).—Figs. 8–10. Slender, subcylindrical; diameter greatest at the fifth abdominal somite; orthocephalic, nearly straight but slightly curved ventrally toward the anterior end; posterior end bluntly rounded. Twelve distinct postcephalic somites. Anus terminal. Vestigial legs small and papilliform. Body and head furnished with a moderately dense covering of simple, slightly curved hairs about 0.05 mm. long. Cranium subtrapezoidal in anterior view with the posterior border broadly rounded and the genae bulging. Antennae small, each with two sensilla. Labrum convex; somewhat broader than long, being broadest above the mandibles; distal border emarginate at the middle; lateral borders feebly emarginate over the mandibular bases; anterior angles broadly rounded; eight spinulose sensilla along the distal border. Mandibles rather heavily sclerotized; base dilated, distal portion very long and slender and curved posteriorly; apex acute; three small teeth near the middle of the medial border. Maxillae round-pointed; palp short and thick with three distal sensilla; galea somewhat more slender, subconical, with one apical sensillum. Labium swollen, protruding, bilobed; palps represented by two clusters of three sensilla each; anterior surface roughened with short rows of spinules; opening of sericteries not evident. Trophorhinium poorly developed, including only the spinulose surface of the labium. (Material studied: numerous specimens from the Philippine Islands.)

A. (T.) martini Forel.—Similar to *A. leviceps*. (Material studied: numerous specimens from the Philippine Islands.)

A. (A.) aratus nesiotis var. **fraterculus** Wheeler.—Figs. 11–13. Similar to *A. leviceps*, but the maxillary palp and galea are larger and the former bears six sensilla. (Material studied: numerous specimens from the Philippine Islands.)

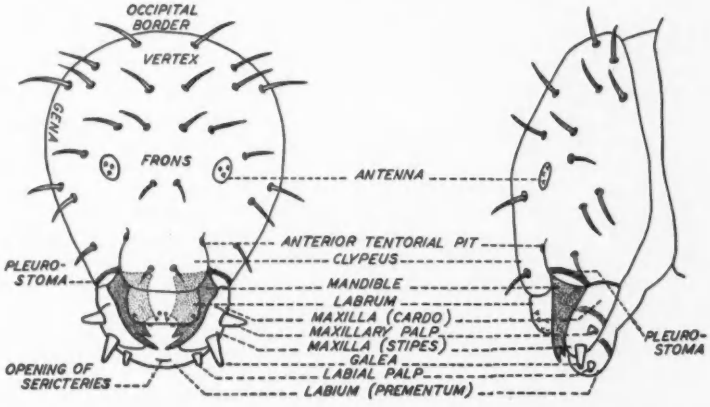
Genus **Eciton** Latreille

Body with simple hairs (Eciton *s. str.* and Labidus) or with both simple and branched hairs (Acamatus). Integument papillose (Eciton *s. str.* and Labidus) or spinulose (Acamatus). Labrum small and inconspicuous. Maxillary palp represented by a discoidal area bearing 5–9 sensilla.

Escherich (1917, p. 95) characterizes Eciton larvae as "*annähernd zylindrisch.*"

Forel (1928, Vol. II, p. 298 = 1923, Tome 5, p. 116) states that the larvae of Eciton "are less nimble and more dependent upon the worker than those of the Ponerinae" ("*bien moins ingambes et plus dépendantes des ♀ que celles des Ponerinae*"). Wheeler (1910, p. 72) describes the larvae of this genus as cylindrical and states (p. 263) that those of Texan species are slender.

E. (E.) hamatum (Fabricius).—Figs. 19–23 and 38. Slender, subcylindrical, orthocephalic; with the anterior end slightly curved ventrally and the rest of the body nearly straight; thickest at the sixth abdominal somite, attenuated toward either end; posterior end bluntly pointed. Vestigial legs relatively large (diameter 0.05 mm.) rounded elevations. Anus ventral. Thirteen distinct postcephalic somites, the terminal small. Body provided with a moderately dense covering of short (0.025–0.12 mm.) simple hairs, which are uniformly distributed. Integument of body beset with short transverse rows of minute papillae, 3 or 4 in each row. Head small, cranium transversely subelliptical in anterior view; rather thickly beset with simple hairs about 0.1 mm. long. Antennae in the form of a minute paraboloid bearing two minute sensilla and mounted eccentrically on a low



Text Figure 2. Synthetic head of an ant larva to illustrate terminology.

elevation. Labrum small, thick, twice as broad as long, with the distal border nearly straight; numerous sensilla on the dorsal surface, a few on the ventral surface and distal border; ventral surface roughened with short arcuate rows of spinules. Mandibles long and narrow with the base dilated, feebly sclerotized and somewhat variable in shape; the apical portion slender and slightly curved medially but not posteriorly; medial borders sparsely denticulate. Maxillae large; the stipes conoidal and furnished with a few spinules; palp a discoidal area bearing one ungulate and 4–8 discoidal sensilla; galea a truncate cone with two apical sensilla. Labium prominent; the prementum subhemispherical; palp a group of four sensilla, three of which form a compact cluster, the fourth isolated; opening of sericteries a long transverse, arcuate slit. Trophorhinium consisting of the spinulose ventral surface of the labrum and the spinules on the maxillae. (Material studied: numerous specimens from the Panama Canal Zone.)

Schnierla has discussed the influence of larvae upon the behavior of the colony:

"The *Eciton* colony makes its nest by gathering into a cluster, and the site of this 'bivouac' changes from time to time. In *E. hamatum* and *E. burchelli* one may ascertain two conditions of general activity, which alternate according to the conditions of the brood. [Schneirla's footnote, p. 321: "W. Müller (Kosmos, 1886), from his study of an *Eciton burchelli* colony, was first to suggest the possibility of a relationship between the food-consuming ability of the *Eciton* colony, as affected by the presence of active larvae, and the general activity of the group."] The colony remains bivouacked in a given place, in the 'statary condition,' first when the eggs are present and during the period that precedes the development of the eggs into food-consuming larvae, and secondly during the period of about three weeks when the young are enclosed in cocoons. In contrast, the colony moves to a new bivouacked site each evening (is in the 'nomad condition') during the time the larvae are naked and consuming food, and again, after the brood has been hatched. Colonies in the statary condition are less active, and raid much less vigorously than when in the nomad condition." (1934, p. 319.)

"The nomadic phase is maintained as a result of the activity of developing larvae. . . . The movements of these larvae, particularly the active twisting movements of their anterior ends, shortly become an important source of stimulation to adult workers. For this it is important that the larvae as they grow larger and become more active are not massed together in the very center of the bivouac as before, but are held by individual workers or are piled up in small numbers in the spaces between ant-strands throughout the interior of the bivouac." (1938, p. 68.)

"To summarize, the foregoing theory is built upon the fact that a brood of larvae which contains many thousands of individuals all at the same stage in development, incidentally stimulates the adults through its activity and thereby greatly increases the general level of colony excitement. This accounts for the marked vigor of each day's raiding, and for the developments of raiding systems by great numbers of workers to an extent which makes a colony migration inevitable at the end of the day. When the maintaining cause ceases to function, colony excitement is markedly reduced and the value of raiding activity falls considerably below the threshold necessary for a general migration. Consequently the colony then enters a very different activity phase in which true migration does not occur." (1938, p. 75.)

In a recent paper (1938) I have described the vestigial legs (p. 140 and figs. 1, 2, and 3) and the vestigial gonopods (p. 141 and fig. 1) of this species. The absence of wing rudiments was also noted (p. 141).

The larval stage of *E. hamatum* lasts 20 days (Schnierla, 1938, pp. 58–61).

E. (E.) burchelli (Westwood). Fig. 37. The mature larva of this species is very similar to that of *E. hamatum*. The distal and lateral borders of the labrum are slightly concave; the maxillary palp has 6–9 sensilla; the galea is a trifle longer and more slender. (Material studied: numerous specimens from Trinidad collected by Dr. N. A. Weber.)

The young larva (i.e., 4–5 mm.) of *E. burchelli* resembles the mature

larva except as follows: the intersegmental furrows are impressed on the sides; the leg vestiges are small and feebly developed; the genae bulge at the level of the antennae; no spinules on the ventral surface of the labrum; the mandibles are a trifle stouter.

Emery (1899, p. 6) described the larva of *E. burchelli*: "Sono entrambe larve subcilindriche, coi segmenti tutti distinti; sono prive di tubercoli o altre appendici e fornite di peli numerosi, brevi e semplici, non esistono peli forcuti, ritorti o uncinati." On Pl. II he figured a larva in profile (fig. 6a), a head in profile enlarged (fig. 6b), mouth parts from in front (fig. 6c), and a mandible and maxilla in profile (fig. 6d).

In an article in the *Atlantic Monthly* (1919, pp. 454–464) Beebe has described (p. 463) cocoon-spinning by the larvae of *E. burchelli* (quoted also by Wheeler, 1921, p. 300). I am quoting it here by permission of the *Atlantic Monthly*:

"On the flat board were several thousand ants and a dozen or more groups of full-grown larvae. Workers of all sizes were searching everywhere for some covering for the tender immature creatures. They had chewed up all available loose splinters of wood, and near the rotten, termite-eaten ends, the sound of dozens of jaws gnawing all at once was plainly audible. This unaccustomed, unmilitary labor produced a quantity of fine sawdust which was sprinkled over the larvae. I had made a partition of a bit of a British officer's tent which I had used in India and China, made of several layers of colored canvas and cloth. The ants found a loose end of this, teased it out, and unraveled it, so that all the larvae near by were blanketed with a gray parti-colored covering of fuzz.

"All this strange work was hurried and carried on under great excitement. The scores of big soldiers on guard appeared rather ill at ease, as if they had wandered by mistake into the wrong department. They sauntered about, bumped into larvae, turned and fled. A constant stream of workers from the nest brought hundreds more larvae, and no sooner had they been planted and debris of sorts sifted over them, than they began spinning. A few had already swathed themselves in cocoons—exceedingly thin coverings of pinkish silk. As this took place out of the nest, in the jungle, they must be covered with wood and leaves. The vital necessity of this was not apparent, for none of this debris was incorporated into the silk of the cocoons, which were clean and homogeneous. Yet the hundreds of ants gnawed and tore and labored to gather this little dust, as if their very lives depended upon it. . . . When first brought from the nest, the larvae lay quite straight and still, but almost at once they bent far over in the spinning position. Then some officious worker would come along, and the unfortunate larva would be snatched up, carried off, and jammed down in some neighboring empty space, like a bolt of cloth rearranged upon a shelf. Then another ant would approach, antenna the larva, disapprove, and again shift its position. It was a real survival of the lucky, as to who should avoid being exhausted by kindness and over-solicitude. . . . There was no order of packing. The larvae were fitted together anyway, and meagerly covered with dust of wood and shreds of cloth. One big tissue of wood nearly an inch square was too great a temptation to be left alone, and during the course of my observation it covered

in turn almost every group of larvae in sight, ending by being accidentally shunted over the edge and killing a worker near the kitchen middens. There was only a single layer of larvae; in no case were they piled up, and when the platform became crowded, a new column was formed and hundreds taken outside. To the casual eye there was no difference between these legionnaires and a column bringing in booty of insects, eggs and pupae; yet here all was solicitude, never a bite too severe, or a blunder of undue force."

According to Wheeler and Bailey (1920, pp. 254–255) the stomach of the larval *E. burchelli* "is unlike that of any other known ant-larvae in being very long and slender and in having unusually thick, muscular walls. The larva is fed, apparently at considerable intervals, with rather large pellets consisting of the rolled up soft-parts of insects. These pellets are so compact that they retain their form in the narrow lumen of the stomach, where they lie in an irregular longitudinal series. Occasionally minute fragments of chitin or a few fungous spores are present, but owing to the feeble development of the larval mouth-parts so characteristic of the Dorylinae, it is evident that the worker must prepare these pellets by carefully trimming away the hard, chitinous portions of their insect prey and rolling up the denser, muscular portions of the flesh. The worker probably consumes much of the exuding juices while engaged in this operation and before stuffing the pellets into the gullets of the larvae."

The passage from Müller (1886, p. 87) referred to above in Schnierla's footnote under *E. hamatum* is as follows: "Der Punkt, wo der Wechsel eintritt, fällt ungefähr zusammen mit dem, wo sich die letzten Larven einspinnen, und dieses Zusammentreffen ist jedenfalls kein zufälliges. Larven brauchen ja im allgemein, besonders kurze Zeit vor der Verpuppung, bedeutend mehr Nahrung als die fertigen Insekten, und so scheint nichts natürlicher, als dass das Nahrungsbedürfnis der Gesellschaft ein geringeres wird und die Tiere entsprechend weniger auf Beute ausgehen, nachdem alle Larven eingesponnen."

Müller's paper bears the title "Beobachtungen an Wanderameisen (*Eciton hamatum* Fabr.)." Wheeler, however, has shown (1921, p. 293) that the species was in reality *E. burchelli*.

Müller described the larvae as "schlank" (p. 82). He observed (p. 89) that spinning and pupation of all larvae takes place within a comparatively short time; from this he concluded that all the individuals were of approximately the same age and that all eggs had been laid within the space of a few days. He also reported (p. 90) that the largest larvae spun first and developed into soldiers. Then followed the largest workers and after them the remaining workers; the younger the larvae were (or the later they pupated) the smaller were the emerging workers.

The specimens regarded by Müller (1886, p. 91 and fig. 2) and by Forel (1891, p. 163) as heteromorphic Eciton larvae are actually some ponerine larva (Pachycondyla) which had been taken in a raid. (Emery, 1900, p. 513, and Wheeler and Long, 1901, pp. 168–172.)

Schnierla's discussion (1934, p. 319) of the influence of the larvae of *E. burchelli* upon the behavior of the colony may be found above under *E. hamatum*.

E. (E.) quadriglume dulcius var. **jujuyensis** Forel.—Gallardo (1920, p. 324) says of this form: "Se puede notar la esbeltez de las larvas que les permite una gran movilidad. . . . " Fig. 8 (on p. 322) is an excellent photograph of these larvae.

E. (E.) vagans (Olivier). These larvae are very similar to *E. hamatum*. (Material studied: numerous specimens from Trinidad collected by Dr. N. A. Weber.) In a recent paper (1938) I have figured (fig. 5) a section through an imaginal bud and vestigial leg.

E. (Acamatus) schmitti Emery—Figs. 29–33. Apparently similar to *E. hamatum*, except in the following characters. The body is densely and uniformly covered with hairs of two types: the majority are simple, straight or slightly curved, and 0.06–0.09 mm. long; a few are bifid or trifid and about 0.05 mm. long. The integument is furnished with short transverse rows of minute spinules. The labrum has 12 sensilla on the anterior surface and lacks spinules on the posterior surface. The apical portion of the mandibles is more slender; the point is more acute; and the denticles are minute and very few in number. The maxillae are without spinules; the palp bears 7 sensilla. Trophorhinium wanting. (Material studied: 8 badly damaged specimens from Colorado).

I have studied a number of male larvae of this species extracted from cocoons 13 mm. long, which were collected in Texas by my brother, Dr. P. A. Wheeler. Since the larvae attain a length of 14–15 mm., the anterior end is sharply recurved to fit the shorter cocoon. In general, however, the shape is typically ecitonine. The wing rudiments appear as short transverse lines (grooves?); vestigial gonopods are wanting on the seventh and eighth abdominal somites and there is only a faint trace on the ninth. There are 13 distinct body somites. The body has a moderately dense covering of hairs which are uniformly distributed in transverse bands separated by naked zones along the shallow intersegmental furrows. These hairs are relatively minute (0.10–0.16 mm.), with the longest at the posterior end where they are flexuous with fine attenuate tips. So many hairs are broken off that the apparent absence of branched hairs is inconclusive; all remaining hairs are simple. The integumental spinules are like those of the worker. The heads of all my specimens are distorted by preservation but they seem to resemble the head of *E. hamatum*, except for genal bulges. The mouth parts resemble those of *E. hamatum* except as follows: the apical portion of the mandibles is more slender, with the denticles larger, more obtuse, and more numerous; the maxillae seems to lack spinules. The mandibles are relatively somewhat smaller than those of the worker.

In a recent paper (1938) I have described the wing rudiments (p. 141) and vestigial gonopods (p. 142) and figured the thorax of the above male in ventral view (fig. 4).

An examination of one damaged larva and one extra head of *E. (A.) sumichrasti* Norton (from Mexico) reveals its close similarity to the larva of *E. (A.) schmitti*.

E. (A.) pilosum F. Smith (figs. 34–36). The larva of this species is likewise similar to *E. (A.) schmitti*, but the hairs are all stiff and plumose and the maxillary palp has only five sensilla. This conclusion is based on eight unsatisfactory specimens from Paraguay.

Eciton (Labidus) coecum (Latreille).—Figs. 24–28. Resembles *E. hamatum*, except in the following characters. The covering of hairs is much less dense. On the thorax the hairs are 0.09–0.11 mm. long and resemble those of *E. hamatum* in form; on the abdomen they are shorter, (0.054–0.072 mm.), stouter, and stiffer, and taper abruptly to a short, sharp point. Hairs of head shorter (0.036–0.054 mm.). The breadth of the labrum is less than twice the length. No spinules were found on the maxillae. The maxillary palp bears six sensilla with the ungulate sensilla more elongate than in *E. hamatum;* the galea is longer and more slender. Opening of sericteries inconspicuous. (Material studied: numerous specimens from British Guiana collected by Dr. N. A. Weber.)

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THE GENERAL COUNCIL ON ZOOLOGICAL NOMENCLATURE

The undersigned zoologists, resident in the United States of America, at the invitation of the Committee on Nomenclature of the American Society of Mammalogists and with the co-operation of the "American Commission on Scientific Nomenclature" of the Entomological Society of America, do hereby associate themselves together as a society and certify as follows:

First: The name of the society shall be the General Council on Zoological Nomenclature.

Second: The objects of the Society shall be:

(A) To act in an advisory capacity in all matters concerning zoological nomenclature during the World War and for such time thereafter as it may consider desirable.

(B) To administer, amend, interpret, and maintain a code of nomenclature for the use of zoologists.

(C) To co-operate with societies maintaining committees on nomenclature, at least those represented in its own membership.

(D) To retain within itself important powers of decision and legislation and of substitutions and additions to its membership, but always subject to full hearings and the advice and counsel of one or more of the committees above mentioned.

(E) To co-operate with zoologists practised in nomenclature who are residents of foreign countries when the war is ended or as soon thereafter as may be practicable.

G. F. Ferris
Wilfred H. Osgood
James A. G. Rehn
George G. Simpson
John T. Zimmer
Remington Kellogg
H. A. Pilsbry
Karl P. Schmidt
A. Wetmore

Merely on the face of it, the above may seem to be a self-constituted body of dubious possibilities and audacious construction. That this is not the case may be evident when its history and purposes are explained. It is the outgrowth of numerous informal discussions among a large number of zoologists during the past few years and of formal action taken by at least two national societies.

Even in years just prior to the war, the International Commission on Zoological Nomenclature was relatively inactive and after hostilities began in Europe in 1939 it became practically nonfunctional. This created a situation in which all co-operative action was endangered and nearly a century's hard earned progress in nomenclature was threatened. Individuals and organizations began to discuss special codes for their separate groups only, and in some cases took definite action. Recently a German (Poche) has promulgated a code of his own and in general at the moment every zoologist having a nomenclatural problem finds himself without appeal to any constituted authority. It was precisely to avoid this condition that codes and commissions were devised.

Discussion among zoologists unanimously recognized the emergency, but it was difficult to arrive at a basis for action which did not involve very great delay and longdrawn controversy. There were those who felt that the international idea could not be abandoned and others who advocated complete divorce from the Old World. The latter pointed

to the success of the International Commission as being mainly due to the American C. W. Stiles whose final conclusion (see Science, 73, pp. 349–354, 1931) was that it was not further workable. Among those holding this opinion were several Europeans.

As announced in *Science* (June 12, 1942) the Entomological Society of America, pursuant to action taken at its meeting in December, 1941, formed an "American Commission on Scientific Nomenclature in Entomology" apparently with the object of proceeding independently. Somewhat later at its annual meeting in April, 1942, the American Society of Mammalogists instructed its standing committee on nomenclature "to act pro-tem in the present world crisis for the Committee (sic) on Nomenclature of the International Commission." The Mammalogists' Committee felt that any committee restricted to a particular branch of zoology would be ineffective. Therefore, with the approval of the Society's President and principal directors, this committee entered into correspondence with the entomologists proposing that the two committees, without further authorization, jointly sponsor the selection of a small group of representative nomenclaturists to "take over," at least for the time being. Full co-operation between the two committees proved impractical without great loss of time, so the Mammalogists' Committee, after receiving encouragement from the majority of the entomologists, selected and organized the group as indicated above. The membership of the Mammalogists' Committee which carried this out was as follows: A. Cabrera, E. R. Hall, G. S. Miller, Jr., W. H. Osgood, T. S. Palmer, G. G. Simpson, and G. H. Tate.

The "Council" thus formed is frankly experimental and the method of its genesis is unusual, but those responsible for it have felt that any other method, especially in these times when large general meetings are interdicted, would defeat itself in prolonged discussion and fatal delay. Under restrictions which the Council has placed upon itself it is hoped that it may be a wholly representative and co-operative body. A brief set of by-laws has been adopted in which important provisions are to the effect (1) that the active membership shall not exceed fifteen, (2) that additions and replacements shall be made only from candidates nominated by large associations of zoologists, and (3) that no important action can be taken without first obtaining the opinion of at least two nomenclatural committees of national societies and several individuals not members of the Council. A judicial function is thus implied preceding any legislation.

It does not propose to supersede any existing special nomenclatural committees, but on the contrary it is designed to stimulate them to greater interest and more action. Its postwar status is problematical, but at least as a temporary measure and an effort in a direction urgently needing attention, it is hoped it may find support. At any early date it is proposed to increase the membership from nine to eleven in order to cover important branches of zoology which are not now well represented.

The by-laws giving details of proposed action are now available for distribution to any interested zoologists who may apply for them

WILFRED H. OSGOOD, *Secretary*,
Field Museum of Natural History, Chicago.

THE FOUNDATION FOR THE STUDY OF CYCLES

The Foundation for the Study of Cycles—a non-profit organization created to foster, promote, and conduct scientific research in respect to rhythmic and periodic fluctuations in any branch of science—announces the offering of a medal to the person who, during 1943, publishes the book or paper in this field that in the opinion of the judges is the most outstanding.

The judges are Dr. C. G. Abbot, Solar Physicist and Secretary of the Smithsonian Institution; Dr. Harold E. Anthony, Curator of Mammals and Dean of Scientific Staff, American Museum of Natural History; Professor W. C. Mitchell, Professor of Economics, Columbia University, and Director of the National Bureau of Economic Research; Professor V. C. Wynne-Edwards, Professor of Zoology, McGill University; and Professor Ellsworth Huntington, Professor of Geography and Climatology, Yale University (Chairman).

It may be in point to recite some of the reasons for assigning high importance to research in cyclic phenomena.

First, in dealing with rhythm and periodicity the scientist is at the very heart of predictability. The power to predict accurately is the acid test of the degree of precision reached in any science. Medical science, for example, would become vastly more effective if we understood the degree to which various diseases are rhythmic in occurrence. Similarly, accurate long range weather predictions, which would be of inestimable value in agriculture and aviation, depend on a knowledge of the nature and causes of the more or less rhythmic variations observed now and in the past.

Second, the techniques for dealing with rhythms and periodicities are much the same in one branch of science as in another, but unless the subject is considered a field by itself, advance in methods in one discipline is often unknown in another until after the lapse of many years.

Third, the subject of rhythmic and periodic fluctuations is important because identical rhythms in unrelated phenomena and unrelated fields of science suggest possible interrelationships that might otherwise escape notice. For instance, long before the cause of tides was understood, the fact that the period of the tides is exactly half the period of the moon suggested that the moon must have something to do with the ebb and flow of the waters.

These are some of the reasons why a concerted study of cycles as a whole is important. There are of course other reasons in respect to individual branches of science.

We must all be careful not to confuse contributions to our knowledge of ***interrelationships*** with contributions to the knowledge of rhythms and periodicities ***per se***. There may be an excellent correlation between two phenomena, and yet no rhythms may be involved in either. The direct concern of the Foundation for the Study of Cycles is only with rhythms and periodicities as such. We must also keep in mind that ***denial*** of the existence of a rhythm may be as important as affirmation.

In addition to awarding a medal, the Foundation will make awards to outstanding work in each branch of science. In these awards the judges will be assisted by the recommendation of an advisor appointed by a scientific society in the branch involved.

The following societies have appointed advisors:

Agriculture—
Am. Soc. of Agronomy
Astronomy—
Am. Assn. of Variable Star Observers
Bacteriology—
Soc. of Am. Bacteriologists
Botany—
Botanical Soc. of Am.
Sec. on Botanical Sciences, A.A.A.S.
Ecology—
Ecological Society
Entomology—
Entomological Soc. of Amer.
Forestry—
Soc. of Am. Foresters
Geography—
Assn. of Am. Geographers
Geophysics—
Am. Geophysical Union
Mammalogy—
Am. Soc. of Mam.
Medicine—
Am. Medical Assn.
Mycology—
Mycological Soc.
Paleontology—
Paleontological Soc.
Seismology—
Seismological Soc.
Sociology—
Am. Sociological Soc.
Statistics—
Am. Statistical Assn.
Insti. of Mathematical Statistics
Zoology—
Am. Soc. of Zoologists
Sec. on Zoological Sciences, A.A.A.S.

Other societies have indicated that advisors will soon be appointed.

ELLSWORTH HUNTINGTON, *Chairman.*

THE FLEAS OF NORTH AMERICA, by H. E. EWING and IRVING FOX. U. S. Dept. Agr. Misc. Publ. No. 500. 141 pp., 57 figs. Index. 1943. Sold by Superintendent of Documents, Washington, D. C. Price 20 cents.

This is a very timely publication with the development of Sanitary Corps and the present general emphasis on the greatly broadened battle against disease carrying insects. Only two previous large publications on American fleas have ever been published, Parker, 1904, on all American fleas and I. Fox, 1940, on fleas of the western United States. The present volume considers all work down to Oct. 1, 1940. Emphasis has been on the study of material on which previous publications were based. Considerable care has been taken in the definition of groups and of species. Rules as to what should be considered generic or subgeneric characters and what should be used as specific characters were laid down in the problem of the valid status of each form. We hope the authors were able to stick to their rules.

The volume lists 61 genera, 14 subgenera, 209 species, and 63 subspecies and varieties. The area covered is that of North America and the West Indies.

—C. H. K.

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